

**Annual Report of Accomplishments and Results
October 1, 2003 to September 30, 2004**

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

COLLEGE OF LIFE SCIENCES AND AGRICULTURE

**UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE**

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2003-2004

INTRODUCTION

The New Hampshire Agricultural Experiment Station (NH-AES) resides within the University of New Hampshire College of Life Sciences and Agriculture. It has the responsibility for the Hatch, McIntire-Stennis, Animal Health, and Multi-State Research Programs. This report of accomplishments does not include New Hampshire Cooperative Extension, which is a separate administrative unit in New Hampshire. However, there is effective coordination of appropriate programs among both units. Through the NH-AES Advisory Committee representing key stakeholder groups, we are working to facilitate constituent input and to improve our delivery of research findings to end users.

A. Planned Programs

Goal 1: An Agricultural System that is Highly Competitive in the Global Economy

Issue

Provide both basic and applied research to support increased knowledge to improve production, marketing and processing of American agricultural products.

Overview:

The New Hampshire AES has established as an outcome indicator increasing the effectiveness of basic and applied projects related to New Hampshire agricultural needs. Additionally, we use the increase in agricultural production in New Hampshire and income growth to New Hampshire farm operations as indicators. Based on the most recent data available from the USDA's New England Agricultural Statistics Service*, the number of NH farms remained stable at 3400 between 2002 and 2003 (but greater than ten years ago). Between 2003 and 2004, the agricultural sector contribution to the State's Economy increased from \$173.3 to \$181.6 million. Total farm assets increased from \$1,063.6 to 1,097.0 million between 2002 and 2003, while total farm debt increased from \$113.4 million to 119.5 million dollars.

We continue our philosophy that the mission of the Agricultural Experiment Station is greater than solely enhancing production agriculture and thus support basic and applied sciences that help position NH to 1) develop new agricultural products and jobs, 2) augment farm-based and farm-related industry, 3) provide opportunities for non-traditional farming endeavors, and 4) create opportunities for farm and rural community development. Each of these areas contributes to the development of a highly competitive agricultural system for the global market.

(*) Sources: New England Agricultural Statistics, 2004

The NH Agricultural Experiment Station supports the following basic and applied projects within Goal 1 to create technology and research for the benefit of the state, region and nation. We believe these projects provided valuable results, excellent return on the investment of AES funds, and a strategic position for the NH AES to successfully achieve the five year POW goals.

Key Theme - Animal Production Efficiency

1. Improve supply of nutrients to dairy cows

a. Brief description of the activity

Two projects are devoted to this issue. Improving the efficiency of conversion of feed protein to milk protein is fundamental to both environmental and economic sustainability of the US dairy industry. Nitrogen and phosphorus are the nutrients of greatest environmental concern. This requires a better understanding of the nitrogen and amino acid requirements of growing and lactating cows, increased efficacy of ruminally protected amino acids, enhanced characterization of feeds, and further refinement of computer-based nutrition models. A collaborative effort among researchers, feed testing laboratories, and the commercial feed industry established the Ruminant Feed Analysis Consortium. This group is analyzing feed analysis for ruminants, quantify relationships between the chemical composition of feeds and nutritive value, and stimulate feed analysis development and standardization. This past year, four cannulated (rumen and duodenum) Holstein cows were assigned to one of four treatments to determine the effect of supplementing a corn-based diet with incremental levels of urea on digestion and synthesis of microbial protein. In addition, an experiment was initiated to evaluate the use of changes in plasma methionine (Met) and total sulfur amino acid concentrations as compared to changes in content and yield of milk protein for measuring the effectiveness of different rumen-protected Met products in their ability to provide absorbable Met to lactating cows.

b. Short Impact/Accomplishment Statement

The research provides information necessary for more precise protein formulation of dairy cattle diets. More precise feeding for protein increases the feed nitrogen conversion to meat and milk protein. This reduces the potential for nitrogen pollution and decreases feed costs. The feed analysis research is to support and enhance diet formulation and evaluation systems. Better systems are needed for more precise matching of nutrient supply with nutrient requirements and thus, result in more environmentally sustainable feeding practices.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch

Total expenditures: Federal - \$ 73,756

State- 151,573

Total – 225,329

Full-time equivalents: Sci. 0.6; Prof 0.6; Tech 1.0; Total 2.2

d. Scope of impact: Multistate; Integrated Research and Extension Project 1 - (CA, FL, IN, IA, KS, KY, LA, MI, MN, NYC, NH, NE, OH, PA, SD, TX, UT, VA, WI.).

Project 2: Multistate; Integrated Research and Extension (AL, AZ, CA, IN, IA, KS, LA,

MI, MN, ND, NH, OH, PA, SD, UT, VT, WA, WI).

2. Predicting bovine fertility

a. Brief description of the activity

Pregnancy losses in cattle during the late embryonic and early fetal period are an economic concern to the cattle industry. Two independent NH projects contribute to a multistate effort to understand ovarian function relative to late embryonic/early fetal mortality in cattle, to determine if environmental/metabolic stressors affect fertility as well as embryonic/fetal survival, and to design strategies to improve reproductive efficiency.

b. Short Impact/Accomplishment Statement

Elucidating the mechanisms by which heat stress affects ovarian function may provide insight toward understanding the lower fertility rates associated with high environmental temperatures during the summer in the northeastern United States. This information will assist in minimizing economic losses to dairy producers. While uterine fluid collections in postpartum cows do not appear to affect ovarian function per se, conception rate is diminished in cows with large fluid collections. Further study of uterine involution in the postpartum cow with regard to conception is warranted, and offers tremendous potential for improving fertility in multiparous cows.

c. Source of funding/total expenditures/full time equivalents (for 2 projects)

Source of funding: Hatch
Total expenditures: Federal - \$33,412
State- 69,871
Total – 103,283
Full-time equivalents: Sci. 0.6; Prof 0.2; Total 0.8

d. Scope of impact: Multistate Research (CTS, MA, NH, NYC, OH, PA, WVA)

3. Improving nutrition for dairy calves

a. Brief description of the activity

Lactoferrin, a milk protein, has antibacterial, antiviral, and growth promoting activity. Our present study is investigating lactoferrin added to conventional milk replacer fed to calves. Calves were provided lactoferrin supplementation to 24 bull calves at two different doses and then slaughtered at 7, 14, and 21 d of life. Intestinal samples were removed and are being evaluated for intestinal changes due to age and lactoferrin. In addition, the antibiotic chlortetracycline on reproductive performance was evaluated in 40 11-month old heifers. Results from these studies in contrast to other stations did not show any benefit with the antibiotic. Lactoferrin has been shown to increase intestinal development in laboratory animals and chickens.

b. Short Impact/Accomplishment Statement

Lactoferrin may increase intestinal development resulting in more efficient nutrient use and healthier calves. Up to now, lactoferrin has only been evaluated in conventional milk replacer feeding regimens. This study will determine its efficacy in high protein milk replacer feeding programs and whether lactoferrin enhances intestinal development. Chlortetracycline is not

beneficial in improving heifer reproductive performance.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$26,614
State- 37,391
Total – 64,005

Full-time equivalents: Sci. 0.3; Prof. 0.6; Total 0.9

d. Scope of impact: Multistate; Integrated Research and Extension (CA, FL, GA, IN, IA, KS, KY, LA, MI, MN, NE, NH, NYC, OH, PA, SD, VA, WI)

4. Lobster habitats and survival

a. Brief description of the activity

This project developed improved methods for determining the area fished by a lobster trap. This information can be used to translate catch data into a calculation of the actual lobsters abundance on the bottom. The movements of 32 lobsters were tracked using ultrasonic telemetry for periods ranging from 24 hours to 7 days. Positional data were collected from each lobster to determine home range and daily patterns of locomotion. Thirty-two lobsters tracked ranged from 100 to 3000 square meters.

b. Short Impact/Accomplishment Statement

Ultrasonic telemetry was used to determine the area of bait attraction around a lobster trap, the home range of a lobster, and the area fished by a trap. By combining the data on the bait attraction area (380 square meters) and the mean home range for lobsters (1000 square meters), it was estimated that 2642 square meters are fished by one trap. This is the first in-depth methodology using the American lobster, which significantly enhances our knowledge of this valuable species. These data and technology will be used to obtain better estimations of the abundance of lobsters, and thus determine fishing impact on the lobster population.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$31,232
State- 75,426
Total – 106,658

Full-time equivalents: Sci. 0.6, Prof. 0.3; Total 0.9

d. Scope of impact: State Specific

5. Oyster and Mussel habitats

a. Brief description of the activity

This project is assessing experimental reefs to increase the production and restoration of oysters and mussels. Data were collected from three experimental constructed oyster reef sites in Hampshire. The three reef sites were constructed in three different ways: 1) using a CROSBreed spat set on oyster shell cultch (Salmon Falls River); 2) using Maine/Muscongus Bay spat on shyster shell and crushed concrete (Adams Point); or 3) using Maine/Muscongus

Bay spat set on two types of crushed concrete (Nannie Island).

b. Short Impact/Accomplishment Statement

The CROSBreed reef initially had good growth and low mortalities but later showed high mortalities. The Adams Point reefs show the best potential with good growth and low mortality. The implementation of full-scale reef restoration will increase the overall productivity and growth of oysters and mussels. The experimentation of different constructed reef types will lead to the optimal artificial reef for restoring shellfish.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$5,318
State- 2,778
Total – 8,096
Full-time equivalents: Prof. 0.5; Total 0.5

d. Scope of impact: State Specific

6. Regulation of bovine follicular activity

a. Brief description of the activity

There is a need to develop methods to identify proteins that may contribute to improved reproductive fertility in agriculturally important animals. This project analyzes important cell signaling proteins that may interact with each other to improve fertility. Specific peptide analogs and antibodies were produced and tested.

b. Short Impact/Accomplishment Statement

Immunohistochemical staining of breast tumor tissues with these specific antibodies demonstrated that activation of the Src kinase correlates with phosphorylation of Tyr-537 of estrogen receptor alpha. Antibody methods to determine when estrogen hormone receptors are in their active state have been optimized. These antibodies also identify peptides that can potentially block estrogen receptor activity. Identification of drugs that block growth of estrogen-dependent tumors and drugs that modulate reproductive effects of estrogen will be possible.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$16,426
State- 49,268
Total – 65,694
Full-time equivalents: Sci. 0.3; Prof. 0.2; Total 0.5

d. Scope of impact: State Specific

Key Theme - Animal Health

1. Genetic bases for resistance to avian diseases

a. Brief description of the activity

This project identified a microsatellite marker as a useful tool to identify chicken major histocompatibility complex (MHC) haplotype in chickens. The marker LEI0258 is located between the BG and BF MHC regions. In further testing, six-week old chickens from parents of B1B2 and B1B5 were wing-web inoculated with 15 pock forming units of subgroup C Rous sarcoma virus (RSV). The B1B2 and B2B2 genotypes had significantly lower tumor profile index than did the B1B1 genotype. Tumors were scored for size six times over 10 weeks followed by assignment of a tumor profile index based on the tumor size scores.

b. Short Impact/Accomplishment Statement

The overall tumor growth for the 70 B1B2 and 78B1B5 chickens were generally regressive. Poultry health will be improved by greater understanding of the genes that affect avian immunity. Improved health represents a substantial economic benefit to poultry breeders and producers.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$30,944
State- 106,709
Total – 137,653

Full-time equivalents: Sci. 0.3; Tech. 1.0; Total 1.3

d. Scope of impact: Multistate Research (AL, AR, CA, CTS, DE, IA, NH, NYC, NC, SC, TX).

2. Causes of soft shell clam decline

a. Brief description of the activity

Leukemic hemocytes from the softshell clam, *Mya arenaria*, both in vivo and in vitro, were used to investigate cytoplasmic anchoring of p53 family member proteins by mortalin (mot-2) using real time PCR, western blots and immunocytochemistry. Real time PCR showed that the p53 and p63/73 had increased expression levels at 14 and 24h following drug exposure.

b. Short Impact/Accomplishment Statement

Western blots and immunocytochemistry indicated translocation of both p53 and p63/73 proteins from the cytoplasm into the nucleus followed an increase in apoptotic cells and a subsequent decrease in viable cells/ml hemolymph. Changes in mot-2 distribution indicate that etoposide treatment may result in dissociation of mortalin and p53 and p63/73 followed by movement of these both transcription factors into the nucleus and apoptosis if tumor cells. We now have a partial understanding of the molecular basis of naturally occurring fatal clam leukemia, a devastating disease in selected clam beds throughout New England. In leukemic clam hemocytes, the protein, mortalin leads to cytoplasmic sequestration of p53 family members, which are tumor suppressors and transcription factors. Since these proteins do not have access to the nucleus, they cannot bind DNA and promote the expression of apoptotic genes that would selectively destroy leukemic hemocytes. This

understanding of a naturally occurring molluscan disease and its development may lead to a large scale treatment of soft shell clams.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch

Total expenditures: Federal - \$26,080

State- 64,074

Total – 90,154

Full-time equivalents: Sci. 0.3; Prof 0.5; Total 0.8

d. Scope of impact: State Specific

Key Theme - Plant Production Efficiency

1. pH and plant nutrition relationships

a. Brief description of the activity

The pH of container media affects the availability of fertilizer nutrients and the resulting plant health. There are important gaps in our knowledge about how to correct substrate pH imbalances. This project examined the efficacy of three Fe forms (Fe-EDDHA, Fe-EDTA and FeSO₄) at supplying FE to both Fe-efficient and inefficient species across a range in pH. Micronutrient toxicity symptoms occurred in Fe-efficient species regardless of Fe form. Maintaining a pH in the moderate range (5.8-6.2) resulted in both health Fe-efficient and Fe-inefficient species regardless of the Fe form.

b. Short Impact/Accomplishment Statement

It was concluded that if substrate-pH could not be maintained within 5.8-6.2, Fe-EDDHA was the best Fe form of those tested at yielding healthy plants. Improved use of lime products for correcting low media-pH problems is now widely used in the industry, and recommendations following this research have been communicated particularly for flowable lime and potassium bicarbonate drenches. Iron-EDDHA is now more commonly-used as a corrective material for iron deficiency at high pH, with improved recommendations based on this research. All of these changes have assisted in reducing (a) crop losses associated with out-of-range media-pH, (b) the associated loss in income and (c) the need for additional pesticide and fertilizer applications to stressed plants.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch

Total expenditures: Federal - \$15,258

State- 21,275

Total – 36,533

Full-time equivalents: Sci. 0.2; Total 0.2

d. Scope of impact: Integrated Research and Extension; State specific

2. Control of plant growth systems

a. Brief description of the activity

This work seeks to develop decision-support tools for flowering potted plants based on plant growth and development models. This has resulted in workshops, an internet case study, a training website called FloraSoil, a collaborative book called "Lighting Up Profits" and development of a training guide using powerpoint slides. Two one-day workshops were developed at NH on greenhouse nutrition, and delivered as an undergraduate course, extension educator in-service training, and two grower workshops in Jan-Feb 2004. The first greenhouse nutrition case study was developed on the internet which surveyed 45 growers, students and fellow academics on its use. A collaborative book on greenhouse lighting was developed and aimed at growers, industry, and university students.

b. Short Impact/Accomplishment Statement

The decision-support systems developed by UNH allow growers to reduce chemical use (fertilizer, growth retardants, and pesticides) by tracking actual versus optimum production levels and are used by 200 growers. Twenty-one universities are using these systems to train new growers in an integrated, scientific approach to crop management. Unique training resources have been developed with 2100 copies (nutrition) currently in use. Traditional (articles, seminars) and innovative (web-based, active-learning) technologies are being used to train growers in improved fertilizer management and lighting energy management methods.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$12,294
State - 21,275
Total - 33,569
Full-time equivalents: Sci 0.2; Prof 0.2; Total 0.4

d. Scope of impact: Multistate; Integrated Research and Extension (CTH, CTS, KY, MI, NH, NJ, NYC, OH, PA)

3. Genetics and breeding of Cucurbita

a. Brief description of the activity

A study on an acorn squash breeding program has yielded several inbred lines with PMT (tolerance to powdery mildew disease). Two of these lines consistently exhibited significantly higher flesh dry matter than previous inbred lines. A hybrid (NH1634) produced from these inbred lines was rated high for appearance, eating quality, storage performance, and plant vigor and yield. A Sweet Dumpling PMT hybrid, NH1615, performed well at several locations in 2003 and 2004 and will be released for possible commercialization in 2005.

b. Short Impact/Accomplishment Statement

Because peduncle deterioration renders pumpkins unmarketable, good stem integrity and color are key attributes for commercial acceptability of ornamental pumpkins. Based on the results on peduncle maturation in pumpkins, we are now able to develop reliable grower guidelines on when to harvest pumpkins and how to grow pumpkins to achieve good stem integrity. Research results from studies on the acorn squash will allow the development of

guidelines and standards for harvesting and marketing squash at wholesale and retail outlets.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$17,498
State- 65,160
Total – 82,658

Full-time equivalents: Sci. 0.2, Prof 0.5; Total 0.7

d. Scope of impact: Integrated Research and Extension; State Specific

4. Small fruit production in modified environments

a. Brief description of the activity

Current matted row strawberry culture requires excessive inputs of labor and chemical weed control agents. The harvest period in this system is short, and is susceptible to weather extremes. Field experiments were conducted with strawberry plants by removal of all or some flowers or day-length extension experiments. None of these treatments affected the mass or volume of primary or secondary berries produced on any of the three cultivars. Thornless blackberries, trained to a swing-arm-trellis showed negligible winter injury and with differences in injury between floating row-cover and uncovered control treatments. It is believed that persistent heavy snow cover throughout the winter (03-04) provided significant protection to plants regardless of treatment.

b. Short Impact/Accomplishment Statement

Interruption of strawberry flower development by day-length extension does not appear from these studies to be a feasible technique for increasing the size of early marketable quality strawberries in under hoop house cultural conditions. An over-wintering and trellis design experiment on thornless blackberry cultivars was established. Plants were trained to a low head swing-arm trellis. The first season of over-winter protection studies showed negligible winter injury.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$21,464
State- 71,715
Total – 93,178

Full-time equivalents: Sci. 0.4; Total 0.4

d. Scope of impact: Integrated Research and Extension; state specific

5. Genetic tools for strawberry

a. Brief description of the activity

Several genomic tools were initiated and/or developed as a basis for connecting specific genes to specific traits in the strawberry. Fosmid libraries were constructed from representatives of the diploid strawberry and mint species resulting in 11 putative protein-encoding genes. Two sequenced clones were mapped and compared to Arabidopsis. Several

putative transposable element-like sequences were also identified within the fosmid sequences. In addition, a cDNA library was constructed from flower bed cDNAs, 3,300 clones were sequenced and about 1900 unique ESTs were identified. Successful crosses were made in an effort to produce synthetic allopolyploids.

b. Short Impact/Accomplishment Statement

The knowledge and genomic tools being developed by this project will enable more effective identification, preservation, and utilization of wild *Fragaria* germplasm for the purpose of developing improved cultivated varieties. The strawberry and mint genome libraries under development will facilitate positional cloning of genes of potential economic interest, and isolation of useful gene promoters. Construction of the strawberry library also constitutes an important first step toward the eventual sequencing of the strawberry genome. The mint research contributes to a needed effort to overcome the industry wide problem of *Verticillium* wilt susceptibility in the cultivated mints, by establishing a diploid system that will facilitate identification, cloning and characterization of genes conferring wilt resistance/susceptibility.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$23,879
State- 74,737
Total – 98,616
Full-time equivalents: Sci. 0.4; Prof 0.9; Total 1.3

d. Scope of impact: State specific

6. Evaluation of new apple cultivars

a. Brief description of the activity

Apple growers in NH are struggling to survive a weak wholesale market. This project studies the potential role new apple cultivars could play in enhancing farm profitability as well as their unique cultural and pest management needs. Yield and fruit quality data have been collected for three crop-years. Data collected included harvest date(s), number of fruit harvested and total weight, starch iodine rating, length/diameter ratios, drops and drop weight. Harvested fruit are being evaluated for storage quality out of cold storage. Several cultivars in this planting have been tentatively identified for grower trial for the roadside stand and U-Pick markets: Silken, September Wonder Fuji, Autumn Blush, Ambrosia and Hampshire.

b. Short Impact/Accomplishment Statement

The shift of the NH apple industry from a wholesale market orientation to a retail market orientation requires that growers offer consumers unique and exceptional varieties. Several cultivars in this planting (Silken, September Wonder Fuji, Autumn Blush, Ambrosia, and Hampshire) have potential for these retail operations at the roadside stand and U-Pick markets.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$1,607
State- 4,078
Total – 5,685
Full-time equivalents: Sci. 0.1; Total 0.1

d. Scope of impact: Multistate; Integrated Research and Extension (AL, AR, CTH, IN, MA, ME, MI, NC, NH, NJ, NYC, NYG, OR, PA, UT, VT, VA, WA, WI, WV)

7. Conservation of plant genetic resources

a. Brief description of the activity

An orange slicing tomato, Orange Blossom, was released through the New Hampshire Agricultural Experiment Station in the fall of 2003 and seed was offered commercially in 2004. During the summer of 2004, 20 experimental, orange-fruited tomato hybrids were evaluated for maturity, plant vigor, fruit size, resistance to cracking, fruit firmness and flavor. Three indeterminate hybrids performed well in 2004 and will be evaluated in multiple locations with trellis culture in 2005. Based on earlier results from 2002 and 2003, the six best NH kabocha squash hybrids were evaluated in 2004 and also distributed for evaluation at several locations in the Northeast. Based on plant vigor, yield, plant growth habit, fruit size, storage performance, and taste evaluation, three hybrids (NH957, NH964 & NH972) have been selected for release for commercial seed production.

b. Short Impact/Accomplishment Statement

The new Orange Blossom tomato variety is the first orange class early slicing tomato that has eating quality equivalent to red varieties. This introduction of this tomato has the potential of having a huge impact on consumer acceptance and demand for orange tomatoes. Several acorn squash hybrids (kabocha varieties) were productive and had superior eating quality to currently available commercial varieties. This breeding program is part of an overall research strategy to educate growers, consumers, produce managers, and produce distributors about factors that determine eating quality in squash, and to develop quality guidelines for winter squash. These kabocha varieties are gradually replacing buttercup in supermarkets because of their more consistent quality.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$19,813
State- 31,698
Total – 51,511
Full-time equivalents: Sci 0.2; Total 0.2

d. Scope of impact: Multistate; Integrated Research and Extension (CTS, MA, ME, NH, NJ, NYG, PA, RI, WV)

8. Role of UVB effects on Plants

a. Brief description of the activity

This project will help determine how UVB is detected by the plant as a prelude to responses

to changes in UVB as a normal part of the environmental signaling system in plants. Three of five experiments have been completed to determine if changes in the chloroplast redox state are involved in detecting low levels of UVB radiation in sunflowers. Data analysis will be completed in 2005.

b. Short Impact/Accomplishment Statement

The results of this study will add to a growing body of knowledge on possible roles redox state changes in chloroplasts play as part of the pathway cells use to detect changes in their environment. This will also add to our understanding of UVB effects on plants.

c. Source of funding/total expenditures/full time equivalent

Source of funding: Hatch
Total expenditures: Federal - \$16,905
State- 45,987
Total – 62,892
Full-time equivalents: Sci. 0.3; Prof. 0.1; Total 0.4

d. Scope of impact: State Specific

9. Nutrient management for ornamental plants

a. Brief description of the activity

The appropriate use of fertilizers has economic and environmental implications. Nitrogen is an effective way to enhance growth; however, it has the potential to leach into ground water. Phosphorus fertilizer is routinely used but may not be warranted for woody plants. Excess phosphorus contributes to surface water degradation. This project examines nitrogen and phosphorus fertilizer management practices for woody and perennial landscape plants. It is intended to improve nutrient use efficiency and prevent excess nutrients in the environment. Two small replicated experiments were established in spring 2004 to test the response of newly planted trees to phosphorus. It will take 2 to 3 years before any measurable differences will be expected.

b. Short Impact/Accomplishment Statement

If current trends continue, extension recommendations will change to emphasize spring/early summer nitrogen application rather than fall fertilization in order to achieve greater N use efficiency and reduce excess N in the environment. The results apply both to nursery production and landscape maintenance fertilization practices. In addition, nitrogen and phosphorous inputs can be potentially be reduced by as much as 50% in field nurseries and landscapes without limiting growth and health of plants.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$12,533
State- 27,507
Total – 40,039
Full-time equivalents: Sci. 0.2; Total 0.2

d. Scope of impact: Integrated Research and Extension; State specific

10. Breeding and genetics of ornamental plants

a. Brief description of the activity

During the duration of this project, a total of 103 breeding lines of *Anagallis* developed at UNH were tested in commercial trials. We have a proposed model for flower color inheritance of blue, orange and red flower colors in this species. Knowing the anthocyanin content of specific *Anagallis* plants, we have been able to design hybridization schemes aiming to obtain new combinations of pigments and novel flower colors. In addition, anatomical and biochemical studies were done on breeding lines with “bicolored flowers,” whereby a combination of red, and blue pigments on the upper and lower petal epidermis results in flower colors ranging from violet to lilac. We are developing artificial hybrids between six *Nolana* species from Peru and five from Chile to gain insight on relationships between species and phylogeny. Some of these species have been selected for breeding, with the main objective of developing sterile interspecific hybrids.

b. Short Impact/Accomplishment Statement

Two new vegetative-propagated *Anagallis* (Pimpernel) cultivars bred at UNH were patented and released in 2003, and about 550,000 cuttings were sold in the first two years. Collaboration with other researchers has resulted in development of a genetic model for flower color inheritance of *A. monelli*, and on studies of taxonomic relationships of Chilean *Nolana* species.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$7,885
State- 18,083
Total – 25,968
Full-time equivalents: Prof. 0.4; Total 0.4

d. Scope of impact: State specific

11. Nutrient management on organic farms

a. Brief description of the activity

Increased agricultural application of organic soil amendments offers opportunities to improve soil quality and weed management as well as challenges to the environment. This study seeks improve nutrient management on farms using organic soil amendments as a fertility source while examining effects of these amendments on weed-crop interactions.

b. Short Impact/Accomplishment Statement

The study of nutrient management on organic farms will define best management practices for organic amendment use. It will address the environmental risks of current nutrient management practices. The forage soybean study is expected to show if cover cropping is a feasible option to reduce the risk of erosion when farmers switch from the perennial alfalfa to the annual forage soybean in their crop rotation. This study is also expected to show if manure, which can potentially be applied at higher rates in the annual forage soybean

compared to the alfalfa, is an effective fertility source.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$5,126
State- 18,351
Total – 23,478
Full-time equivalents: Prof. 0.4; Total 0.4

d. Scope of impact: Integrated Research and Extension; State specific

12. Development of Nutrient Management

a. Brief description of the activity

Certain soil chemical characteristics and agricultural management practices can contribute to an increased risk of offsite nutrient movement. This project will identify the most relevant soil characteristics and management practices that have a direct effect on nutrient movement and will modification of approaches to reduce the risk of offsite nutrient movement through leaching or runoff. Soils were collected from agricultural fields around the state to represent a majority of prime agricultural soils and soils of statewide importance. This involved approximately third five soil series and represented the major soil orders found in NH.

b. Short Impact/Accomplishment Statement

Demonstrating that soil test phosphorus levels beyond the optimum or high range has no economic return and can increase the risk of environmental issues occurring on farms has helped farmers to reduce or eliminate phosphorous from chemical fertilizer sources. Evaluating alternative practices such as cover crops to supply nitrogen, or winter cover crops to reduce soil erosion and phosphorus movement will result in improved management decisions by land crop managers.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$6,349
State- 0
Total – 6,349
Full-time equivalents: Total 0.0

d. Scope of impact: Integrated Research and Extension; State specific

Key Theme - Plant Health

1. Inhibition of photosynthesis by UV-radiation

a. Brief description of the activity

Two projects are assessing this issue. These efforts are investigating 1) long-term effects of high salinity (covering a six fold range) on growth, photosynthesis and antioxidant parameters, and 2) whether UV-B radiation is detected via the redox system in chloroplasts. Growth rates were reduced by 72% from 0.7 to 0.2 divisions per day at the hyper-saline

extreme indicating that the cultures were highly stressed.

b. Short Impact/Accomplishment Statement

At high salinity cells showed major decreases in glutathione but with no changes in alpha-tocopherol. The involvement of oxidative stress at high salinity is implied by the alterations in antioxidant enzymes and substrates. Salinity is a major stress factor reducing crop productivity world wide. The precise roles of anti-oxidants in mediating this stress are not understood. As *Dunaliella* is the most salt-tolerant eukaryotic photosynthetic organism known, an improved knowledge of its anti-oxidant responses to salt stress can be significant in improving crop plant productivity. The second project will provide valuable information on the means by which chloroplasts detect changes in UV radiation. Our results will also contribute to a growing body of knowledge about the role and importance of the chloroplast redox state in plant signaling and acclimation to environmental change.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$16,956
State- 44,918
Total – 61,873
Full-time equivalents: Sci. 0.6; Total 0.3

d. Scope of impact: State Specific

Key Theme - Plant Genomics

1. Molecular biology of seed coat development in pumpkin

a. Brief description of the activity

Although the technology of artificial seeds has made significant advances, we still know little about the development of seed coat to mimic this process. The proposed research is aimed at delineating the molecular events related to seed coat and embryo development so that these processes can be manipulated in a desirable way. A S-adenosylmethionine decarboxylase (SAMDC) cDNA was compared with the genomic sequence and showed that there at least two SAMDC genes in carrots. To determine if this was a functional gene, one of the genes was express in an inducible vector deficient in SAMDC activity. Further studies included an analysis of mRNA expression. An example of such manipulations will be the production of soft-seed-coated or `hull-less' varieties of commercially important seeds.

b. Short Impact/Accomplishment Statement

An understanding of the molecular events during seed coat and embryo development will aid in the cloning of commercially useful plants, and lead to the development of genetically improved plants for enhanced nutrition and agronomic characters in crop plants. Information about polyamine metabolism during embryo development will also aid in cloning plants that are difficult to clone by routine methods of vegetative propagation.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch

Total expenditures: Federal - \$18,201
State- 32,109
Total – 50,310

Full-time equivalents: Sci 0.1; Total 0.1

d. Scope of impact: State specific

2. Calcium control of plant enzyme activity

a. Brief description of the activity

Thirty-four genes for calcium-dependent protein kinases (CDPKs) have been identified in the fully-sequenced genome of the model plant *Arabidopsis thaliana*, although only 29 of these genes are known to be expressed. This project has determined that the optimum cycle number for 20 of the 29 CDPK genes are known to be expressed. Future experiments will focus on determining the expression patterns and stress induction for additional CDPKs.

b. Short Impact/Accomplishment Statement

The results to date indicate that some CDPKs have distinct expression patterns while others are expressed at comparable levels in all tissues. Calcium-dependent protein kinases are known to be important for plant responses to pathogen attack, drought stress, wounding, etc. This research has the potential to identify the specific CDPKs involved in the response to each stress so that the correct CDPK could be modified to adapt plants for specific environments or to improve plant growth and productivity.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$17,719
State- 46,736
Total – 64,455

Full-time equivalents: Sci. 0.3, Prof. 0.5; Total 0.8

d. Scope of impact: State Specific

Key Theme - Aquaculture

1. Genetic improvement of tilapia for aquaculture

a. Brief description of the activity

Two projects continue to develop and use genetic maps to study commercially important traits in tilapia. In one project, a genetic map was completed with more than 550 microsatellite and gene-based markers. Databases and comparative genome viewers were constructed to relate the tilapia map to the linkage maps and genome assemblies of Fug, Tetraodon, medaka and zebrafish. A patent will be awarded for our discovery of a method to use a microsatellite in the prolactin gene to identify fish with appropriate genotypes for rearing at different salinities. A major XY sex-determining system in the Nile tilapia and a WZ system in blue tilapia were identified. Ongoing studies involve the positional cloning of the dominant gene causing red skin color in Tilapia.

b. Short Impact/Accomplishment Statement

We are using the genomic resources we have developed for tilapia to identify the genetic basis for several commercially important traits in tilapia, including sex, skin color and salinity tolerance. These discoveries have immediate applications for breeding improved strains of tilapia for commercial aquaculture. The development of genetic and physical maps is expected to lead to complete sequencing of the tilapia genome as a model fish species.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$29,960
State- 86,520
Total – 116,480

Full-time equivalents: Sci. 0.3, Prof. 0.8; Total 1.1

d. Scope of impact:

1. State specific
2. Multistate Research (AL, CA, CTS, LA, NH, NJ, VA)

2. Increased efficiency of producing sea urchins

a. Brief description of the activity

Declining wild harvests of green sea urchins in the Gulf of Maine will require hatchery systems for both stock enhancement and aquaculture. Without active intervention, the potential for a sustainable urchin fishery will not be realized. The fall, 2003 period was focused on analysis of recruitment samples from the summer field season and renovations to the hatchery for the winter, 2004 larval cultivation season. The results suggest that growth rates are more than adequate to produce juveniles for out-planting the following winter. Collaboration with urchin harvesters in Eastport, Penobscot Bay, Casco Bay, Maine was undertaken to test suspended cages for collecting wild settlers for possible stock enhancement and future aquaculture efforts.

b. Short Impact/Accomplishment Statement

Successful hatchery production of juvenile urchins was accomplished for the seventh year in a row, confirming that a hatchery for urchin aquaculture is feasible. Suspended cage systems have proved to be effective for both juvenile grow out and for increasing production through natural recruitment into the cages.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$28,881
State- 68,214
Total – 97,095

Full-time equivalents: Sci. 0.3, Prof. 0.4; Total 0.7

d. Scope of impact: State Specific

3. Control of pigment production of summer flounder

a. Brief description of the activity

Correct establishment of body asymmetry is important in cultured flatfish because of its links to pigmentation development. This project has documented and quantified the appearance of different types of pigment cells on the ocular and blind sides during larval stages and through metamorphosis. Detailed analyses of the cytological basis of pigmentation also offer insights into the relationship between global and local patterning mechanisms, as reflected by pigment cell differentiation. Initial attempts at PCR amplification of a flounder homolog of *pitx2* were unsuccessful. Future studies will attempt to resolve the technical issues of PCR.

b. Short Impact/Accomplishment Statement

Initial progress on this project lays the necessary groundwork for further analyses that will enable us to examine the establishment of flatfish asymmetry in more detail, and thus better understand the relationship between asymmetry and pigmentation abnormalities that are costly to the aquaculture industry.

c. Source of funding/total expenditures/full time equivalents

Total expenditures: Federal - \$8,898
State- 31,127
Total – 40,025

Full-time equivalents: Sci. 0.3; Total 0.3

d. Scope of impact: State Specific

4. Taxonomy of the seaweed *Porphyra*

a. Brief description of the activity

The red seaweed *Porphyra* ("nori") is the basis of a US\$1.2 billion per year industry in Asia, primarily for use as human food (sushi). There is interest in establishing a nori industry in the U.S. based on native species of *Porphyra*. The goal of this study is to examine the taxonomy and ecophysiology of *Porphyra* species native to the coast of New England. Using molecular tools to indicate species boundaries, the range of morphological cytological, and ecological characteristics of each species has been examined.

b. Short Impact/Accomplishment Statement

There is interest in establishing a nori industry in New England based on native species. The work has been completed on *Porphyra purpurea*. This work shows that *P. purpurea* is morphologically and ecologically far more variable than previously reported. In addition, further studies showed that carotenoids in *Porphyra* were found to function primarily as reactive oxygen intermediate quenchers rather than as photosynthetic light collection pigments. The results of the project will facilitate the establishment of a commercial nori aquaculture industry in New England based on native species of *Porphyra*. It will also contribute to our understanding of the taxonomy of the species and will result in the description of a number of new species.

c. Source of funding/total expenditures/full time

Source of funding: Hatch
Total expenditures: Federal - \$17,068

State- 54,523
Total – 71,591

Full-time equivalents: Sci. 0.3; Prof 0.3; Total 0.6

d. Scope of impact: State specific

5. Marine finfish aquaculture

a. Brief description of the activity

Declines in wild fisheries necessitate aquaculture of marine finfish. The purpose of this study is to develop methodology for marine finfish culture in coastal New Hampshire waters. In November, 2003, 20,000 juvenile cod (mean 13 g) were stocked at two different densities in two specially built nursery cages located at a marina in Rye, NH. Upon harvest in May, mean fish weight was 25 g and there was no difference found between stocking densities. In June 2004, 12,500 juvenile fish were stocked in both inshore and offshore nursery pens. Upon harvest in September, fish in the inshore cage averaged 16.9 g, approximately 40% larger than those reared offshore. The growth differential between sites was attributed to greater feeding frequency and more moderate temperatures at the inshore site.

b. Short Impact/Accomplishment Statement

The results from this project are the first to demonstrate hatchery rearing and subsequent offshore production of Atlantic cod in the U.S. The development of marine fish aquaculture in NH waters has the potential for tremendous impact on the local seafood market. Culturing cod and striped bass in NH coastal waters would diversify the aquaculture industry in the northeast and likely provide regional seafood at competitive prices.

c. Source of funding/total expenditures/full time

Source of funding: Hatch

Total expenditures: Federal - \$19,599

State- 36,122

Total – 55,722

Full-time equivalents: Sci. 0.3; Prof 0.2; Total 0.5

d. Scope of impact: State specific

Key Theme - Other

1. Genetics and Glycosylation in soil nematodes

a. Brief description of the activity

Nematodes are major causes of losses in animal and crop agriculture but can only be controlled by quarantine or resistant crop varieties. Two projects contribute to this activity. The first study is characterizing the contribution of N-glycosylation to nematode development as a prerequisite to the development of selective control methods based on species-specific glycosylation. A genome-wide screen for glycosylation-dependent loci has been initiated. The second study will enhance our understanding of agriculturally important nematodes through genetic analysis in these species. The complete genome sequence of the related nematodes *C. elegans* and *C. briggsae* is being used to identify transposon resident

sites conserved between the two genomes. In addition, all available expression data are being compiled from *C. elegans* microarrays to identify clusters of genes that are up- or down-regulated in concert in response to developmental or other cues.

b. Short Impact/Accomplishment Statement

Using *C. elegans* as a model nematode, one study will identify gene-products that depend on glycosylation for proper function and determine which are nematode or species specific. This group of genes will be a set of novel targets for nematicide development through perturbation of their protein or glycan components. The second study will provide insight into the role of transposons in regulation of host gene functions in eukaryotic genomes, and the mechanism by which RNAi regulates gene expression and chromatin density. Our bioinformatic analysis of transposon distribution provides a detailed view of the genome architecture of this important model organism.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch

Total expenditures: Federal - \$31,983

State- 77,371

Total – 109,354

Full-time equivalents: Sci. 0.6; Prof. 0.7; Total 1.3

d. Scope of impact: State Specific

2. Character and control of yeast regulatory interactions genes

a. Brief description of the activity.

Two projects contribute to this activity. The first study is investigating the functional and physical interactions of yeast regulatory genes to identify the factors that control gene expression. Project one demonstrated close connections between two gene regulatory protein complexes that appear to control several aspects of gene expression. The second work is analyzing the mechanisms by which a leucine-rich repeat (LRR)-containing yeast protein recognizes and binds to other proteins. Project two found a highly conserved 4-residue consensus motif that binds a variety of NOT LRR proteins.

b. Short Impact/Accomplishment Statement

The results are important to understanding how gene expression is controlled both in terms of synthesis and degradation. In the first study, the actions of poly(A) have been clarified in its interaction with the CCR4-NOT group of proteins; all are important regulators of protein expression in plant and animal organisms. These studies may have broad implications in understanding how protein expression can be controlled in medically and agriculturally important organisms. In the second study, the protein LP1 is of particular interest because it is may be a key modulator of whole-body cholesterol homeostasis. Should peptide LP1 be found to be effective in specifically blocking or modulating cholesterol absorption by the Npc1L1 protein, this study could provide a framework for the development of therapeutic drugs to regulate cholesterol metabolism.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$47,895
State- 96,442
Total – 144,335
Full-time equivalents: Sci. 0.6; Prof. 1.0, Total 1.6

d. Scope of impact: State specific

Program Duration

The research projects that contribute to this goal are generally of three to five years duration. All projects are targeted for mid and long term problems.

In fiscal year 2004 the New Hampshire Agricultural Experiment Station had 10.2 full time equivalents of scientists time assigned to Goal 1. Their research was funded with federal funds from the Hatch, McIntire-Stennis, and Multi-State Research Programs. There were 2.0 full-time equivalents of technical and clerical staff attached to these projects. Professional help, in the form of graduate students doing research on these projects, amounted to 7.1 students. For this goal, as well as all subsequent goals, the State of New Hampshire provides matching funds through a line item within the University of New Hampshire's budget. It is not anticipated that any small changes in federal funding in the next five years would significantly alter the spectrum of key program components for Goal 1.

Goal 2: A Safe and Secure Food and Fiber System

Issue: Foods are in constant threat of contamination by microorganisms. The agricultural system has a responsibility to ensure that the foods produced are safe to eat.

Overview:

The New Hampshire AES has established output indicators for Goal 2 as follows: 1) increase research results from projects dealing with microorganisms that are potential harmful contaminants of foods and 2) increase understanding of the processes whereby harmful microbes carry out their infective and disease-causing processes. As outcome indicators, we evaluate 1) an absence or decrease of bacterial contamination of foods and 2) the level of public awareness of the contribution of pathogenic microbes to animal and human illness. We continue a philosophy that the mission of the Agricultural Experiment Station is consistent with Goal 2 and thus provide support to basic and applied sciences that help NH to 1) reduce bacterial illness, 2) determine the role of bacterial genes in diseases, 3) provide defense mechanisms against pathogenic bacteria, and 4) assess the impact of pathogenic bacteria on humans, animals and the environment. We also support programs to enhance public awareness of food safety issues. The NH AES also supported the following basic and applied projects within Goal 2 to create technology and research for the benefit of the state, region and nation. We believe these projects provided excellent results and value from the investment of AES funds and have positioned the NH AES well to successfully achieve the goals of its five year POW plan.

Key Theme - Food Safety

1. Role of bacterial genes in diseases

a. Brief description of the activity

A better solution to reducing the bacterial population on meats without collateral hazards or radiation-induced spoilage, and more practically applicable is needed. The project's aim is to assess the susceptibility of wild type and regulatory mutants of *E. coli* to environmentally benign acidification and probiotics. The effects of acetic acid on the survival of an *E. coli* strain 0157:H7 were determined. All media containing one percent acetic acid prevented the growth of this bacterium and acid tolerance was not found to occur at this concentration.

b. Short Impact/Accomplishment Statement

Confirmation that the *yihG* sequences influence toxin production in *E. coli* 0157:H7 provides a basis for better understanding the pathogen in general and additional results may eventually lead to a means for control of the pathogen. A means of altering bacterial pathogens where they could serve as effective immunogens or as probiotic agents to control unwanted microorganisms in the environment. The health of the human and domestic animals should benefit from these findings.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch

Total expenditures: Federal - \$21,545

State- 68,373

Total – 89,918

Full-time equivalents: Sci. 0.2, Prof. 0.4; Total 0.6

d. Scope of impact: State Specific

2. Host defenses against Salmonella

a. Brief description of the activity

Foodborne disease in humans due to *Salmonella* continues to be a major health concern. The purpose of this project is to determine how salmonella attach to human cells and to explore approaches that may block that attachment and thus prevent disease. Food-associated illness due to animal-derived *Salmonella* remains a major health problem in humans. By understanding the molecular and cellular events involved in *Salmonella* infections we can develop intervention strategies for reducing illness associated with these bacteria. The effect of porcine MBL-opsonized *S. Typhimurium* on apoptosis of human gastrointestinal epithelial cells was examined and determined to be both invasive and capable of surviving intracellularly in T84 cells.

b. Short Impact/Accomplishment Statement

Salmonella are highly successful pathogens of both animals and humans. Although individuals exposed to *Salmonella* have a number of strategies for preventing infection, these bacteria have developed effective counterstrategies, one of which is inducing a form of cell suicide in neutrophils, an important first line of defense against *Salmonella* infections. This project has established the base line rate of apoptosis in untreated neutrophils using an enzyme-linked immunoassay that detects DNA fragmentation. By finding ways of preventing this enhanced killing of key defense cells, we can maintain the health of animals and humans

exposed to Salmonella.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$28,271
State- 72,785
Total - 62,415
Full-time equivalents: Sci. 0.3; Prof. 0.3; Total 0.6

d. Scope of Impact: State specific

3. Impact of microcystins on lakes

a. Brief description of the activity

Cyanobacteria toxins, microcystins, are found world-wide in lakes and are linked to serious health problems. This research has detected cyanobacteria microcystins I more than 80 NH lakes representing a range of trophic conditions. A major goal of this project is to identify sources of microcystins (MCs) in NH lakes. While MC production is usually associated with 4 or 5 large-sized net phytoplankton species, this study investigated the smaller picoplankton contributors (<2 um). The results showed that the smallest phytoplankton components contributed significantly to the MC load in lakes. This project is now examining more closely the types of picoplankton present and their susceptibility to zooplankton grazing, as this may be the major pathway for accumulation of MCs in the food web.

b. Short Impact/Accomplishment Statement

Potent liver toxins, called microcystins (MCs) are a worldwide problem that is increasing as lakes become more eutrophic. While bloom forming cyanobacteria are generally believed to be the major source of MCs in eutrophic lakes, this research suggests the smallest sized picoplankton is responsible for the toxicity found in more pristine lakes. Thus it is important to determine the specific sources of biotoxins so that appropriate toxin management protocols can be developed.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$25,838
State- 75,690
Total – 101,528
Full-time equivalents: Sci. 0.3, Prof. 0.5; Total 0.8

d. Scope of Impact: State Specific

Program Duration

All projects under this goal are for a three to five year period. All projects are targeted for mid and long term problems.

In fiscal year 2004 the New Hampshire Agricultural Experiment Station had 0.8 full time

equivalents of scientists time assigned to Goal 2. Their research was funded with federal funds from the Hatch Program. There were 0 full-time equivalents of technical staff attached to these projects. Professional help in the form of graduate students doing research on these projects amounts to 1.2 students. For this goal, there are matching funds from the State of New Hampshire through a line item within the University of New Hampshire's budget. It is not anticipated that any small changes in federal funding in the next five years would significantly alter the spectrum of key program components for Goal 2.

Goal 3: A Healthy, Well-Nourished Population

Issue: The reasons people eat particular foods are complex and the foods that are included in a diet have short-term and long-term health consequences. Knowledge of food-consumption patterns and the results of those choices are needed.

Overview:

The New Hampshire AES has established as output indicators for Goal 3, 1) increased research results from projects dealing with why particular foods that make up a diet are chosen and 2) increased research results detailing the short and long term consequences of food consumption patterns on health issues.

We will evaluate as outcome indicators if our efforts within this goal are contributing to 1) healthier food choices resulting in a better balanced diet for consumers and 2) fewer incidences of disease or disorders directly related to improper diet choices.

We continue a philosophy that the mission of the Agricultural Experiment Station is consistent with Goal 3 and thus provide support to basic and applied sciences that help posture NH to 1) understand and control the metabolism and oxidation in adipose tissue, 2) assess the nutritional risk in the elderly, 3) understand relationships of diseases and gender or age, and 4) assess the functional properties of food protein. Each of these areas contributes to developing and assuring a healthy and well-nourished population. The NH Agricultural Experiment Station supports the following basic and applied projects within Goal 3 to create technology and research for the benefit of the state, region and nation. We believe these projects provided excellent results and value from the investment of AES funds and have positioned the NH AES well to successfully achieve the goals of its five year POW plan.

Key Theme - Human Health

1. Obesity, insulin resistance and asthma in women

a. Brief description of the activity

Overweight and asthma are two chronic health conditions that are closely related. Both conditions are higher in females than males. Present research is aimed to determine whether the relationship between asthma and overweight are caused by imbalances in sex hormones and loss of insulin sensitivity. This study is testing the hypothesis that insulin resistance is a risk of asthma development. The design of this study was cross-sectional involving 21 obese and 22 non-obese women, ages 18-41 years. Insulin resistance was determined using fasting insulin resistance index and by oral glucose tolerance test. The frequency of atopy was

almost three times higher among obese than non-obese women. Plasma concentration of estradiol, ratio of estradiol:SHBG and leptin were higher among obese than non-obese women.

b. Short Impact/Accomplishment Statement

The present study is the first show that fact mass is a predictor of atopy in women and that the immune condition may be mediated by an increase in estrogen availability and insulin resistance. Rate of childhood asthma has almost tripled in the U.S.A. in the last twenty years. Maternal antibodies are transferred readily to the fetus during pregnancy. Obesity, a preventable condition, may not only increase the risk of allergy and asthma development in women, but also in their children.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$24,269
State- 117,891
Total – 142,161
Full-time equivalents: Sci. 0.4, Tech 0.9 , Total 1.3

d. Scope of Impact: State Specific

2. Control of adipose tissue metabolism

a. Brief description of the activity

Obesity, characterized by excess adipose tissue accumulation, has reached epidemic proportions world-wide. This project studies metabolic processes in intact adipose tissue that contribute to adipose tissue accumulation in the Yucatan miniature swine model. This project had two lines of investigation during the past year. The first was to examine the relationship between obesity and inflammation in the miniature swine model. A pilot study is in progress using three pair of littermate swine testing a 3-month dietary treatment. Following this treatment, adipose tissue will be examined. In the second line of investigation, the impact of cellular energy was determined on human adipocyte lipolysis in vitro. Glycerol was measured as an index of lipolysis.

b. Short Impact/Accomplishment Statement

This is the first report to examine the effects of AMP activated protein kinase (AMPK) activation on lipolysis. The findings suggest that AMPK's role in lipolysis may be a function of the adipose tissue region, adipocyte size or individual variation. Fat cell enlargement is the hallmark feature of obesity. The findings of this project contribute to our understanding of how fat cells may regulate their own size. The long-term impact of these findings is the knowledge toward reducing the negative health, economic and social outcomes of obesity.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$21,373
State- 44,190
Total – 65,563

Full-time equivalents: Sci. 0.3; Total 0.3

d. Scope of Impact: State Specific

3. Molecular basis of visual function

a. Brief description of the activity

Two projects are examining defects in visual function. Blindness and visual disorders in humans and animals are often caused by biochemical disorders of the retina such as genetic diseases involving faulty opsin genes or errors in opsin gene expression. The goal is to characterize the poorly studied cone visual signaling pathway to understand how defects in cone function lead to photoreceptor degeneration, visual impairment and ultimately, blindness. The data to date supports the hypothesis that part of the physiological differences between rods and cones can be attributed to differences in the regulatory properties (cGMP and Pg binding) of the rod and cone PDE6 during visual transduction. Efforts are continuing to isolate physiologically competent suspensions of cone photoreceptors free of rod cell contamination. Furthermore, work will identify genetic factors, which control opsin gene expression. The second project has identified contigs of BAC clones containing specific opsin genes in the cichlid fish tilapia. Identifying these factors will lead to a better understanding of these diseases and might enable gene therapies to cure them.

b. Short Impact/Accomplishment Statement

Studying how cone photoreceptor cells function at the biochemical level is essential for understanding the initial events in daytime vision and color discrimination. This information is needed to develop effective treatments to slow or reverse diseases of the photoreceptor cells that lead to impairment of visual function or even total blindness. Our recent advances in understanding the cone visual pathway, particularly the cone phosphodiesterase enzyme, may help design better therapeutic agents that selectively target this enzyme in cone cells. Opsins are the first proteins in the signaling transduction cascade which convert light into a neural output of the retinal photoreceptors. Because of their critical function, misexpression of opsins or mutation at sites which are key to opsin function and signal transduction lead to photoreceptor cell death and often blindness. In the second project, the control of opsin gene expression will be determined as well as sites, which are critical for opsin function. This information will enable molecular testing to identify the cause of disease, but could also lead to cures through gene rescue therapy.

c. Source of funding/total expenditures/full time equivalents (for 2 projects)

Source of funding: Hatch
Total expenditures: Federal - \$34,049
State- 56,360
Total – 90,409

Full-time equivalents: Sci. 0.3; Prof 0.3; Total 0.6

d. Scope of Impact: State Specific

4. Regulation of zinc transport

a. Brief description of the activity

Zinc is an essential nutrient that needs to be present in the proper amounts to support optimal health. This project examines potential mechanisms for cellular zinc transport and its regulation. The regulation of brain zinc homeostasis was investigated using an in vitro blood-brain barrier (BBB) model composed of porcine brain capillary endothelial cells. A 628 bp sequence of the ZnT-1 transcript was isolated from porcine brain capillary endothelial cells. The expression of the porcine ZnT-1 is been tested for expression by relative concentration of mRNA. The results will help us understand how the proper amounts of zinc are delivered to the proper locations in the body.

b. Short Impact/Accomplishment Statement

This project is making progress to identify how the brain carefully adjusts the relative rates of zinc (Zn) transport into the brain to accommodate high or low blood Zn concentrations. Expression of pZnT-1 mRNA was elevated by 169% at 12 hr after application of the high zinc medium. By 24 hr, expression had declined to 59% above controls, and it returned to baseline (4% below controls) after 48 hr of exposure. These results indicate that after an initial increase in pZNT-1 expression, brain capillary endothelial cells suppress transcription of the gene. These data will improve our ability to evaluate the significance of zinc malnutrition in the development of brain disorders like Alzheimer's disease and dementia.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$20,277
State- 49,025
Total – 69,031
Full-time equivalents: Sci. 0.3; Prof. 0.4; Total 0.7

d. Scope of Impact: State specific

Key theme - Human Nutrition

1. Assessing the nutritional risk of the elderly

a. Brief description of the activity

The focus of this project was to look at modifiable nutritional factors that influence disease risk in the elderly. Fruit and vegetable consumption is associated with a decreased chronic disease risk, especially conditions related to oxidative stress. Retinal macular pigment, composed of carotenoids, is thought to act as an antioxidant to protect the visual system. Since humans do not synthesize carotenoids, these must be of dietary origin, and dietary supplements are being marketed with a focus on eye health. Biochemical markers and dietary assessment tools for nutritional status, coordinated with intervention and education strategies are imperative for decreasing disease risk in the elderly. This project focused on dietary carotenoids and their deposition in the retina, as measured by macular pigment optical density. Adults aged 45-75 were evaluated for dietary practices, anthropometrics, serum carotenoids and MP measured as macular pigment optical density (MPOD).

b. Short Impact/Accomplishment Statement.

The density of macular pigment (MP), composed of the dietary carotenoids lutein (L) and

zeaxanthin (Z) was evaluated as a biomarker of fruit and vegetable consumption. There was a significant difference in MPOD for low consumers versus the medium to very high consumers of fruit and vegetables. There was a difference observed in age quartiles and most significantly, BMI appears related to MPOD. Body mass index also was significantly and inversely related to MP. Increasing dietary intake of lutein in the form of food (spinach) or supplement significantly increased MP suggesting MP is mutable even in both young (below 25) and older (above 45). Modifiable factors such as diet and weight appear to influence MPOD. These findings may have significant public health implications if MP is determined to protect the retina from aging eye diseases.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$28,193
State- 49,529
Total – 78,442
Full-time equivalents: Sci. 0.3; Prof 0.2; Total 0.5

d. Scope of Impact: Multistate Research (CTS, DC, ME, MD, MA, NH, NYC, PA, RI)

2. Atherogenesis in normal and diabetic animals

a. Brief description of the activity

Cardiovascular disease is the number one cause of mortality in American men and women. Diabetes, whose incidence is increasing in America, accelerates atherosclerosis development. This project examines the role of diabetes in the development of atherosclerosis by investigating four hamster groups: 1) Control, fed a low fat diet of standard chow, 2) hyperlipidemic fed a high fat diet of supplemental chow, 3) hyperglycemic as induced by streptozotocin (Stz) and 4) hyperlipidemic/ hyperglycemic fed a high fat diet and given Stz. Immunohistochemistry for the LDL receptor, malondialdehyde and the lectin-like oxidized LDL receptor were performed.

b. Short Impact/Accomplishment Statement

Hamsters injected with Stz developed hyperglycemia as indicated by significantly higher fasting glucose levels. Hamsters that were either hyperlipidemic or hyperglycemic had positive immuno-histochemical (IHC) staining for low-density lipoprotein (LDL) receptor (LOX-1) in endothelial cells and smooth muscle cells. Hyperglycemia increased the proatherogenic LDL and altered it to a more readily oxidizable form in the hyperlipidemic/hyperglycemic hamster. This is substantiated by the significantly elevated plasma lipid hydroperoxides in the H group. The elevated glucose (hyperglycemia) of diabetes type II will have significantly adverse health effects on an increasingly obese human population. Understanding how this state promotes cardiovascular disease may lead to therapies to lessens the impact of diabetes. The receptor that was the focus of this study may be the target for pharmaceutical intervention to reduce the major cause of illness and death in diabetics. This project has established that the hyperlipidemic/hyperglycemic hamster is a valid model for future studies in this area.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$25,542
State- 69,266
Total – 94,808
Full-time equivalents: Sci. 0.3; Prof. 0.7; Total 1.0

d. Scope of Impact: State Specific

3. Atherogenesis at the cellular level

a. Brief description of the activity

Spontaneous atherosclerosis in pigeons is an autosomal recessive trait. The overall objectives of this project were to identify the genetic and metabolic bases for spontaneous atherogenesis in susceptible White Carneau pigeons through comparisons with resistant Show Racer pigeons. Primary aortic cell cultures were established for each breed to eliminate organismic effects from comparisons between the vascular cells. Morphological, ultrastructural, and biochemical chronologies of abnormalities leading to cholesteryl ester-containing foam cells in susceptible WC aortas were established. A library of cDNA differentially-expressed between aortic smooth muscle cells of WC and SR pigeons has been prepared by subtractive hybridization and is being characterized in attempts to identify the gene in question.

b. Short Impact/Accomplishment Statement

Studies with several thiazolidanedione drugs showed that linoleic acid-induced cholesteryl ester accumulation in pigeon aortic cells is regulated by PPAR-gamma but appears independent of increases in the chondroitin-6-sulfate-containing glycosaminoglycan, versican. Genetic susceptibility to cholesteryl ester accumulation was shown to reside at the level of arterial smooth muscle cells and was also expressed in smooth muscle cells from various White Carneau pigeon tissues under culture conditions. Cross-breeding and back-cross matings showed that susceptibility was inherited as a single-gene, autosomal-recessive trait. Heart and blood vessel diseases are the leading cause of death in the United States. Although a variety of factors are involved in development of fatty deposits in arteries, genetic factors are major determinants, and heart disease (atherosclerosis) has been described as the most prevalent genetic disease affecting humans. In pigeons, this disease (which is similar to the human condition) is exclusively determined by a single gene. Identification and characterization of this gene will provide a major advance in reducing the death rate from heart disease. In addition, it appears that expression of this gene depends on specific components of fats in the diet.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$26,406
State- 70,620
Total – 97,026
Full-time equivalents: Sci. 0.3; Total 0.3

d. Scope of Impact: State Specific

Key Theme - Food Quality

1. Protein Structure During High-pressure Cycling

a. Brief description of the activity

High pressure is used as a method of sterilization and preservation of food substances. There is no conclusive data showing how pressure cycling affects biological molecules. While scientists understand the effects of static high pressure on molecular structure, the causes of the reported effects of the pressure cycling are not known. The purpose of this project was to design, construct and test modifications to a pressure-cycling apparatus that will permit optical evaluation of molecules throughout pressurization and depressurization cycles. The barocycler device proved to be of limited value in examining protein structure due to its pressure limits. And because the barocycler was not available, this project instead looked at the charge effects of protein nonideality using other means.

b. Short Impact/Accomplishment Statement

Recent data show that the nonideality of trace quantities can be determined of a protein with known valence, added to solutions containing a high concentration of proteins also of known valence. The results reveal 1) charge-charge nonideality dominates the trace-protein's behavior; 2) the nonideality can either be repulsive or attractive depending on the sign of the charge on the proteins; and 3) when attractive, relatively stable clusters of proteins results. These observations will be important to the understanding and control of protein function. Further work is needed to test these results.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch

Total expenditures: Federal - \$24,165

State- 54,269

Total – 78,434

Full-time equivalents: Sci. 0.3; Prof 0. 4; Total 0.7

d. Scope of Impact: State specific

2. Nutritional content of vegetable brassicas

a. Brief description of the activity

This project has determined the impact of genetic and environmental influences on elemental and phytochemical contents of vegetable Brassicas. The vegetable Brassicas are significant sources of RDA nutrients as well as beneficial health promoting phytonutrients, such as carotenoids. Twenty-two kale and collard cultivars and selections suitable for NE were evaluated for elemental accumulation over two growing seasons. The potential to enhance Ca in kale tissues was evaluated in both field and greenhouse studies. An additional study screened the same 22 kale and collard cultivars for levels of carotenoid phytochemicals.

b. Short Impact/Accomplishment Statement

On average, a two-fold difference in Ca, Mg, K, Fe, and Zn elemental concentrations among the cultivars and selections was determined. Results from the Ca studies showed that

producers can modify the levels of Ca in kale leaf tissue through higher Ca application rates. In the carotenoid study, there was a significant difference in carotenoid accumulations between two consecutive years of field evaluations. Information from these studies has made an impact on cultural management practices and cultivar selections made by NH and NE vegetable producers. Research results have been provided to stakeholders through publications and web-site dissemination. On-farm research demonstrations on three NH farms were attended by over 200 people during the summer of 2003. These results continue to highlight the nutritional value of the vegetable Brassicas and both genetic and environmental influences that impact nutritional value.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$15,614
State- 27,798
Total – 43,412
Full-time equivalents: Sci. 0.2; Total 0.2

d. Scope of Impact: State specific

Program Duration

The research projects that contribute to this goal are generally of three to five years duration. All projects are targeted for mid and long term problems.

In fiscal year 2004 the New Hampshire Agricultural Experiment Station had 2.7 full time equivalents of scientist's time assigned to Goal 3. Their research was funded with federal funds from the Hatch and Multi-State Research Programs. There were 0.9 full-time equivalents of technical and clerical staff attached to these projects. Professional help in the form of graduate students doing research on these projects amounts to 2.0 students. For this goal, there are matching funds from the State of New Hampshire through a line item within the University of New Hampshire's budget. It is not anticipated that any small changes in federal funding in the next five year's would significantly alter the spectrum of key program components for Goal 3.

Goal 4: An Agricultural system which Protects Natural Resources and the Environment

Issue: Agriculture is a human activity and as such goes on within a larger environment. Agriculture and forestry activity can have major impacts on soil and water and land ecology and its environment because of their direct links to soil, water, air, and biological resources.

Overview:

The New Hampshire AES has established as output indicators for Goal 4, research activity that deals with the problems associated with agricultural and forestry practices as related to the environment. We will evaluate the outcome indicator of whether our efforts within this goal are contributing to an agricultural and forestry industry that is productive yet minimizes

environmental impact. We continue a philosophy that the mission of the Agricultural Experiment Station is consistent with Goal 4 and thus provide support to basic and applied sciences that help posture NH to maintain a sustainable environment and forest industry.

The NH Agricultural Experiment Station supports the following basic and applied projects within Goal 4 to create technology and research for the benefit of the state, region and nation. We believe these projects provided excellent results and value from the investment of AES funds and have positioned the NH AES well to successfully achieve the goals of its five year POW plan. Each of the following projects contributes to maintaining a sustainable environment.

Key Theme - Biodiversity

1. Genetic diversity of northeastern conifer species

a. Brief description of the activity

Deforestation, air pollution and climate change impact the distribution and population structure of conifers species in forests. A survey of mitochondrial and chloroplast haplotype diversity for range wide samples of red, black and white spruce was completed. Work continues to further differentiate mitochondrial haplotypes within each species. Additional mitochondrial loci have been amplified using a new set of mitochondrial primers designed from Norway spruce. Further sequencing is planned to identify potential single nucleotide polymorphisms (SNPs) for each species.

b. Short Impact/Accomplishment Statement

The results to date suggest that black spruce and red spruce are sister taxa and not a progenitor/derivative species pair. In order to understand the current population structure of New England's dominant spruce species, it is important to understand evolution of the species. Red and black spruce have hybridized frequently as the species range moved North and West since the last glaciation. These results help explain how different populations of spruce respond to climate changes.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis

Total expenditures: Federal - \$23,011

State- 42,413

Total – 65,424

Full-time equivalents: Sci. 0.3; Prof 0.2; Total 0.5

d. Scope of Impact: State Specific

2. Forest management and plant biodiversity

a. Brief description of the activity

The biodiversity of forested ecological reserves is dynamic and may decline due to natural succession and as adjacent areas become developed. Our purpose is to determine natural disturbance regimes in forested ecological reserves and determine how these factors influence biodiversity of these sites. The research this past year focused on two parts 1)

dynamics of NH pitch pine forests and 2) dynamics of NH transition hardwood forests.

b. Short Impact/Accomplishment Statement

Three types of forest communities were found in New Hampshire's Ossipee Pine Barrens: the "pitch pine community type", dominated by pitch pine with some white pine; the "mixed pine-hardwood community type", composed of similar amounts of pitch and white pines and red maple, and with small amounts of other hardwoods; the "red maple community type", dominated by red maple but including red oak, American beech, and white pine. These results for the Ossipee Pine Barrens are being used by the Nature Conservancy and other landowners to formulate a management plan, including a prescribed fire plan that will maintain biodiversity in the Ossipee pinelands. The glossy buckthorn work is the first to demonstrate a negative effect of buckthorn on tree regeneration and thus will assist policy makers in deciding whether or not to ban sales of this shrub.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - \$37,995
State- 93,947
Total - 131,942

Full-time equivalents: Sci. 0.5; Prof 0.5; Total 1.0

d. Scope of Impact: State specific

3. Floristic diversity in old growth forests

a. Brief description of the activity

Both the world scientific community and public have become increasingly concerned with the state of the world's biodiversity at local, national and global scales. The composition of a forest's flora is one truly important measure of forest biodiversity. This project is focusing on the composition of the insular flora of secondary forest on islands in Lake Winnepesaukee. Primary efforts included a literature review, and initiating field research on Timber Island: establishing survey methods, setting up transects, beginning a floristic inventory.

b. Short Impact/Accomplishment Statement

Preliminary plant identifications have been made of specimens collected to-date. The project is critical to a more comprehensive understanding of botanical diversity in forests of New Hampshire and the northeast, and helps establish important baseline data in comparing managed and unmanaged forests.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - \$15,756
State- 24,397
Total - 40,154

Full-time equivalents: Sci. 0.2, Prof 0.2, Total 0.4

d. Scope of Impact: State specific

4. Predicting range expansion in the Gulf of Maine for introduced species

a. Brief description of the activity

Seaweed biodiversity assessments are useful in evaluating both short and long-term changes. Detailed field studies have been conducted at several sites within Casco Bay and the Gulf of Maine to evaluate seaweed biodiversity patterns and numbers of invasive species. Molecular evaluations have also been used to delineate different strains and/or species of the economically important red alga *Porphyra*, many of which are difficult to delineate.

b. Short Impact/Accomplishment Statement

The occurrence of the invasive Asiatic (introduced) green alga *Codium fragile* ssp. *Tomentosoides* has been documented at several sites within the Gulf of Maine, with the plant dispersing southward from Boothbay Harbor (i.e. mid-coastal Maine) by vegetative fragments and south-flowing currents and northward via expansion of attached populations through the Cape Cod Canal near Plymouth, Ma. A comparison of long-term floristic changes within Casco Bay, Maine has shown varying patterns of % similarity and species richness within different embayment, as well as the possible introduction of the cosmopolitan red alga *Dumontia contorta* from Europe. The significances of these studies are three fold 1) the pattern and mechanisms of introductions of invasive species are being delineated, hopefully aiding with their management and control; 2) the proposed Sea Grant studies (spinoff) will attempt to clarify if multiple and genetically diverse populations are colonizing the Gulf of Maine and 3) the systematic and molecular studies are helping to clarify patterns of species diversity and possible introduction.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$23,477
State- 63,851
Total – 87,328
Full-time equivalents: Sci. 0.3; Total 0.3

d. Scope of impact: State Specific

5. Biodiversity of aquatic plants

a. Brief description of the activity

Biodiversity in New England versus tropics is considerably underestimated. Field studies in the temperate latitudes focused on botanical diversity of two large peatlands within the Lake Umbagog National Wildlife Refuge developed as a consequence of raised water levels in the lake after construction of the Errol, NH, dam in 1853.

b. Short Impact/Accomplishment Statement

The botanical inventories document a vascular flora of 178 species recorded in the 2 peatlands, 111 of which occur in both peatlands; the Leonard Marsh flora consists of 50 families, 96 genera, and 142 species, while 50 families, 96 genera, and 148 species compose of the flora of Harpers Meadow. The study shows that aquatic/wetland plant diversity

appears to be richer than that of the tropics and therefore conservation of our wetland ecosystems of northeastern North America is extremely important. A better understanding of the biodiversity in our wetlands is needed to aid in conservation and management decisions.

c. Source of funding/total expenditures/full time equivalent

Source of funding: Hatch
Total expenditures: Federal - \$13,077
State- 39,140
Total – 52,217

Full-time equivalents: Sci 0.1, Prof. 0.2; Total 0.3

d. Scope of Impact: State specific

Key Theme - Biological Control

1. Endocrine control of reproduction in fish

a. Brief description of the activity

In the Great Lakes Region and Lake Champlain, lampreys are considered a major deterrent to fish populations because of the lamprey's parasitic phase in the lake in which it feeds on other fish with its suckorial mouth and extracts body fluid often causing high mortalities. Our purpose is to develop an alternate method of sterilizing male sea lampreys using analogs to brain hormones that control reproduction. Three projects were completed this past year including 1 & 2) the interactions and spatial expression of gamma aminobutyric acid (GABA) and gonadotropin releasing hormone (GnRH); and 3) determining the efficacy of several microencapsulated GnRH analogs in radio-receptor assays to determine binding affinities.

b. Short Impact/Accomplishment Statement

The results from these studies showed that GnRH and GAD are produced in cell populations in and around the third ventricle of the hypothalamus. This close spatial relationship of GABA neurons and GnRH neurons provides a basis for a regulatory role of GABA on GnRH neurons in the sea lamprey involved in reproductive maturation and spawning. Studies revealed a power GnRH agonist D-Arg6 mGnRH. This information can be used for sterilizing lampreys in a sterile-release program in the Great Lakes Region and Lake Champlain as well as in fish aquaculture. Gaining a further understanding of gonadotropin-releasing hormone, its analogs, its receptors, interactions with neurotransmitters and microencapsulation will be critical for development of novel strategies for improving and controlling reproduction.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$28,774
State- 117,017
Total – 145,791

Full-time equivalents: Sci. 0.3; Prof. 1.6; Total 1.9

d. Scope of Impact: State Specific

2. Hormonal control of beetle reproduction and rearing characteristics

a. Brief description of the activity

Hormonal control of parental care and reproduction are not well understood in insect species with multiple, opportunistic reproductive bouts. The overall of this research is to establish the role of juvenile hormone (JH) in burying beetles, which serve as a model species for insects, which rely on an opportunistic breeding resource. This project has investigated the interaction between the endocrine system and the physical and social environment in the regulation of extended biparental care. This project tested the hypothesis that higher juvenile hormone (JH) was a response to the need for increased parental care by manipulating brood size. In another study, some social (presence of a mater, mating history, larval age) and environmental (carcass size) factors were investigated that that may affect the endocrine profile.

b. Short Impact/Accomplishment Statement

There was a significant positive correlation between JH titers and larval growth but there was not a correlation between JH titers of single males caring for small versus large broods. Many beetles that have regular or opportunistic reproductive cycles with some period of parental care are pests (e.g. passalid beetles and bark beetles). Juvenile hormone (JH) agonists and antagonist have been used to control these populations. This project is using burying beetles as a model system because they are easy to manipulate and the behaviors and hormone profiles are so striking. If JH has a limited or no role in reproduction but has a significant role in modulating reproductive behaviors in these beetles, this information is potentially invaluable information for the development of methods to control populations of economically important beetle species that have parental care and opportunistic breeding cycles.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$11,995
State- 32,902
Total – 44,896

Full-time equivalents: Sci 0.3; Prof 0.2; Total 0.5

d. Scope of Impact: State specific

3. Microbial mechanisms for bioremediation

a. Brief description of the activity

The goal of this project is to examine how bacteria degrade hydrophobic, petroleum-based pollutants to help enhance bioremediation. These studies examine the mechanism and purpose of bacteria internally pooling oily petroleum-based pollutants within their cells. In particular, acinetobacter and several species within other genera were examined for their ability to degrade various alkane (C8-C18) substrates. This information will help to facilitate using bacteria to clean-up contaminated sites.

b. Short Impact/Accomplishment Statement

The alkanes were provided in both liquid and vapor phase as the sole carbon and energy source. Each culture demonstrated a specific range of chain length alkanes on which they grew, and growth rates were found to vary greatly depending on the substrate. Alkane utilization was also dependent upon whether the substrate was provided as a liquid or vapor phase. These results combined with prior findings showed that inclusion body contents in different genera are not always an unmodified alkane substrate, suggesting that there is no common mechanism by which bacteria take-up and degrade alkanes. The expected impact of this research is bioremediation. Petroleum products are the most common pollutants in the environment, and the use of bacteria to degrade these toxic chemicals can be enhanced when we have a clear understanding of the microbial mechanisms involved in this process.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$12,985
State- 51,708
Total – 64,693
Full-time equivalents: Sci 0.3; Prof 0.5; Total 0.8

4. Impact and Control of Trematode Parasites

a. Brief description of the activity

Trematode parasites influence commercially and ecologically important marine species and human health. This project addresses what factors most strongly influence trematode species diversity and overall prevalence within marine nearshore communities and determines at what spatial scale they operate. A spatially explicit database of the diversity and abundance of trematode parasites infecting the host snail, *Littorina littorea*, was compiled from more than 40 sites along the New England coast. Environmental parameters, physical measurements and biological measurements were recorded at each site.

b. Short Impact/Accomplishment Statement

A complex spatial analysis of the database in collaboration with some environmental statisticians has been completed and final analysis and write-up is in progress. Determination of the drivers of parasitic infection may ultimately be a powerful means to understand the determinants of trematode population dynamics across spatial scales, thus helping to predict and address trematode impacts on commercially and ecologically important nearshore marine species. Secondly, because impacts to nearshore environments may affect species in different ways, the power of using trophically-transmitted parasites as indicator species is that they potentially integrate the effects of nearshore impacts across many species from different trophic levels with different physiologies and life history strategies.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$16,982
State- 30,260
Total – 47,241
Full-time equivalents: Sci 0.3; Prof 0.2; Total 0.5

5. Molecular Markers and Control of Two Flatworm Pests

a. Brief description of the activity

Marine flatworms commonly prey on mussels and oysters and can have great impact on bivalve aquaculture. The main goals of this project are to isolate DNA markers that can be used to track these flatworms. High molecular weight genomic DNA has been isolated from marine flatworms and enriched for microsatellites. One hundred-ninety two clones have been selected and sequenced. Microsatellite identification among these sequences is currently being performed.

b. Short Impact/Accomplishment Statement

To date, a cytochrome oxidase (CO-I) gene has been tentatively identified as the best candidate for a mitochondrial DNA maker. The selected flatworm is a new invasive species to the Gulf of Maine. Over the last three years, its populations have undergone an explosive growth to densities as high as 1000 individuals per square meter. The worms are voracious feeders and because of their high densities, leave an impact on locally available prey items. An understanding of their population genetics and dispersal patterns is imperative for their control.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch

Total expenditures: Federal - \$15,864

State- 41,875

Total – 57,739

Full-time equivalents: Sci 0.3; Prof 0.2; Total 0.5

Key Theme - Forest Resource Management

1. Controls on Forest Soil Solution Chemistry

a. Brief description of the activity

Forest soil solution chemistry is an indicator of overall ecosystem function and a driver of stream water quality in forested watersheds. This project examines the effects of experimental manipulations of nitrogen and organic matter inputs on the nitrogen and organic matter found dissolved in soil solution. The effects of organic matter and nutrient supply on the solution chemistry of forest soils were determined by sampling soil solution from lysimeters at three long-term experimental manipulations.

b. Short Impact/Accomplishment Statement

Results pooled across all the sites and experiments show that production of dissolved organic carbon is remarkably insensitive to N additions and the changes in ecosystem structure (primary productivity, soil microflora) that accompany N fertilization. This project provides fundamental information about controls on soil solution chemistry in forest ecosystems, with an emphasis on factors controlling the production and delivery of dissolved organic carbon and nitrogen to surface waters. Dissolved organic carbon and dissolved organic nitrogen are important in aquatic nutrient cycles and as contaminants in drinking water supplies. Better understanding of forest nutrient cycles will improve forest management and facilitate

predictions of changes in forests with changing climate.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - \$20,989
State- 35,328
Total – 56,317

Full-time equivalents: Sci. 0.2, Prof. 0.5, Total 0.7

d. Scope of Impact: State Specific

2. Role of fungi in forest floor nutrient availability

a. Brief description of the activity

Removal of coarse woody debris from the forest may adversely affect soil nutrient availability. This project determines if the decay fungi found in decaying coarse woody debris are linked to and transport minerals from mineral soil. Decay fungi transport elements into decaying wood but the origin of these elements is not clear. If the fungi in the wood are connected to the mineral soil, from which they obtain certain elements, ultimately replenishing the organic soil, then forest management practices may need to be modified.

b. Short Impact/Accomplishment Statement

Isolates of *Hypholoma sublateritium* were identified in all substrates by sequencing their nuclear ribosomal DNA in the ITS1-5.8SITS2 region using the primers ITS1-4. The potential transfer of elements and compounds by *Hypholoma sublateritium* via a hyphal bridge from mineral soil to decaying woody debris implies new pathways for biogeochemical cycling within forests and may lead to a reevaluation of forest management practices.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - \$23,654
State- 55,538
Total – 79,192

Full-time equivalents: Sci. 0.4; Total 0.4

d. Scope of Impact: State Specific

3. Measuring stocking and structure in N. H. forests

a. Brief description of the activity

Improved description of forest stocking and structure is needed to meet increasing social demands for market and non-market benefits of managed forests. This project tests a series of stocking and structural measures, and develops guidelines for their use. One project has been completed that includes analysis of leaf area, stocking, and growth relationships in the permanent plot network supported by this project.

b. Short Impact/Accomplishment Statement

Results show that simplistic depictions of stocking relationships previously discussed in the

literature are not applicable, and that growth is well correlated with leaf area index independent of age or other measures of site quality. These results provide forest managers improved tools for predicting forest growth. Better assessment of uncertainty will improve decisions about thinning pine stands and the management of stand structure in the northeast U.S.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - \$25,157
State- 31,850
Total – 57,007
Full-time equivalents: Sci. 0.3, Prof. 0.2, Total 0.5

d. Scope of Impact: State specific

4. Remotely sensed forest vegetation mapping

a. Brief description of the activity

Forest vegetation maps derived from moderate spatial resolution remotely sensed imagery have lesser accuracy than most of the user community desires. The overwhelming complexity and mixture of tree species in the New England and Great Lakes states makes this problem especially true. With the advent of higher spatial resolution imagery and greater computer power, it may be possible to improve the accuracy of these forest vegetation maps. This project has evaluated traditional approaches for mapping New England forests from high spatial resolution imagery and found these approaches yield poor results. More advanced pixel-based techniques were also tried and failed. In the last year of this work, texture based methods and image segmentation were used to mimic the human interpreter by creating polygon areas.

b. Short Impact/Accomplishment Statement

Data from the texture based methods and image segmentation produced low results, but were statistically significantly better than the results from the previous methods. Further development of these polygon methods offers the best chance of producing highly accurate forest vegetation maps in the Northeast United States and other places where the forests are especially complex. Field visits to monitor our natural resources are not cost effective or efficient. The use of remote sensing and other spatial data analysis tools have become commonplace for mapping and monitoring our every changing planet. The continued development of techniques for improving our abilities to make accurate maps are essential to our continued wise use of our natural resources.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - \$27,346
State- 38,623
Total – 65,969
Full-time equivalents: Sci. 0.3, Prof. 0.2, Total 0.5

d. Scope of Impact: State specific

5. Genetic control of stress response of trees

a. Brief description of the activity

The goal of this research is to genetically manipulate the metabolism of polyamines (putrescine, spermidine and spermine) in poplar cells in order to test if this alteration causes positive physiological responses of the cells to osmotic, salinity and aluminum stress. The consequences of overproduction of putrescine in transgenic cells of poplar (*Populus nigra* x *maximoviczii*) expressing an ornithine decarboxylase transgene were studied in relation to the effects of different concentrations of nitrogen in the medium on several physiological parameters.

b. Short Impact/Accomplishment Statement

The results show that the amount of nitrogen in the growth medium is not a limiting factor for continued production of higher amounts of putrescine in the transgenic cells. However, continued supply of both ammonium and nitrate is required in order to maintain the homeostatic levels of putrescine in both cell lines. The presence of higher amounts of putrescine in the transgenic cells had significant effects on the physiological parameters that were studied. The results of research will lead to the modeling of the regulation of a metabolic pathway that will allow the use of polyamine pathway as an early stress indicator in plants. The availability of an early indicator of stress is useful in devising strategies at mitigation of stress and management of forest trees.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis

Total expenditures: Federal - \$25,221

State- 23,204

Total – 48,425

Full-time equivalents: Sci. 0.2; Prof 0.5; Total 0.7

d. Scope of Impact: State Specific

6. National atmospheric deposition program

a. Brief description of the activity

During this past year, chronic nitrogen additions to forest soils were examined in how they interact with climate warming to alter microbial community composition and nutrient cycling dynamics. During the fall of 2003, soil cores were collected from the control, disturbance control and heated plots at the Soil Warming Study at Harvard Forest located in Petersham, MA. Total physiologically active microbial biomass was determined by substrate-induced respiration. Catabolic response profiles were obtained by measuring the short-term respiration responses to 25 substrates.

b. Short Impact/Accomplishment Statement

Active microbial biomass was 26% and 44% lower in the heated compared to control plots for the O-horizon and mineral trend, though not significant, toward lower total and particulate organic matter C contents. A significant effect was observed of warming on the

overall respiratory response following addition to soil of 25 organic substrates. Principle components analysis indicated that patterns of substrate use, normalized to account for differences in microbial biomass, were significantly different between treatments for the mineral soil, but not the O-horizon material. Specific information on the influence of nitrogen deposition on different forest stands (pine versus hardwood) will help identify forests particularly susceptible to this disturbance and to anticipate forest decline of economic importance in New England.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$22,555
State- 45,481
Total-68,036

Full-time equivalents: Sci 0.3; Prof. 0.7; Total 1.0

d. Scope of Impact: State Specific

Key Theme - Water Quality

1. Insect-based water quality statements

a. Brief description of the activity

This project has evaluated water quality in New Hampshire streams and developed biotic indices for estimating water quality. The major groups of stream insects of southern New Hampshire have been identified, and keys for identification prepared.

b. Short Impact/Accomplishment Statement

Ninety species of mayflies, 50 species of stoneflies, and 40 species of caddisflies were found, which are the three most valuable groups of insects for evaluating all but the lowest water quality streams. The keys and water quality data will allow New Hampshire aquatic biologists to easily identify insects used as water quality indicators to species. Distribution patterns in New Hampshire, and patterns in seasonality reveal that time of sampling and area of sampling will influence the water quality values determined due to the faunal differences and differences in the tolerance values for species. This will allow rapid and precise statements of water quality by local, state and federal organizations.

c. Source of funding: Hatch
Total expenditures: Federal - \$33,311
State- 112,222
Total – 145,533

Full-time equivalents: Sci. 0.8; Prof. 2.0; Total 2.8

d. Scope of Impact: State specific

2. Pathogen persistence in Class B limed sludge (2 projects)

a. Brief description of the activity

Land application of biosolids may pose a public health risk due to the presence of pathogenic

microorganisms. Two projects evaluate the effectiveness of several conventional biosolids treatment processes on the fate of pathogens (adenovirus, astrovirus and Cryptosporidium).

b. Short Impact/Accomplishment Statement

To help alleviate the anxieties associated with the land application of biosolids, several different pathogens and potential indicator organisms were assessed for their survivability in alkaline stabilized biosolids. Similar inactivation conditions used at treatment plants in NH and across the US were evaluated at a bench scale level. All the pathogens tested to date are rapidly inactivated by alkaline treatment. In addition, results also show that bacteriophage may serve as a candidate indicator organism. Clostridium perfringens is a spore forming anaerobic bacteria, which is ubiquitously present in raw sewage. It has been considered as an alternative to parasites in assessing treatment effectiveness mainly because it is easily cultured and not expensive to evaluate. If a correlation between this anaerobe and other true pathogens could be determined, than results of C. perfringens viability could be extrapolated to parasitic pathogens.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$32,020
State- 66,515
Total – 98,535

Full-time equivalents: Sci 0.5; Prof 0.2; Total 0,7

d. Scope of Impact: Project 1 – Integrated Research and Extension; State specific
Project 2 – State specific

3. Application of sewage biosolids to agricultural soils (2 projects)

a. Brief description of the activity

Land application of biosolids has proven to be a controversial agricultural practice. Biosolids are valuable as soil amendments, but their land application can affect numerous systems. Two projects examine the effects of long-term application of biosolids on water quality, pathogen persistence and soil microbial biodiversity.

b. Short Impact/Accomplishment

Application of sludge as biosolids to the land remains a practice enveloped in controversy. The results from one project showed that regulations and permit conditions were not sufficiently protective of groundwater quality at sites where repeated applications of biosolids are made. Changes in NH state regulations were made as a result of this study. The second project is being done on the survival and migration of pathogens once they have been applied to the land. The results indicate the inactivation of MS2 would be a good indicator of the inactivation of REO under the same conditions. Land application of biosolids remains a very contentious topic. However, land fills are quickly running out of room and ocean disposal or incineration are not viable options, hence, other alternatives that move us as a society towards sustainability need to be explored. To help diminish the apprehension often encountered in the land application process, further research is being done on the survival

and migration of pathogens once they have been applied to the land.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$21,300
State- 47,785
Total – 69,085
Full-time equivalents: Sci 0.2; Total 0.2

d. Scope of impact:

1. State specific
2. Multistate; Integrated Research and Extension (DE, MA, NJ, PA, NYC, NH)

4. Transport of E. coli in New Hampshire aquifer sediments

a. Brief description of the activity

Feces from livestock and poultry are potential sources of enteropathogenic microorganisms such as bacteria, viruses, and protozoa. Because of the common use of the normally nonpathogenic E. coli as an indicator organism for fecal contamination of drinking water supplies, this research will focus on understanding the transport behavior of E. coli through aquifer sediments commonly found in southern New Hampshire. These data will assist regulatory agencies in establishing guidelines for protecting groundwater supplies for contamination by pathogenic bacteria.

b. Short Impact/Accomplishment

Groundwater contamination by enteropathogenic microorganisms is a national health concern in the United States. Bacterial transport through aquifers occurs via the processes of advection (transport only due to the flow of water), dispersion (when a zone of mixing spreads mass beyond the region of advection), attachment and detachment. Bacteria that have attached to the aquifer material can remain there permanently or become detached from the solid phase and re-enter the aqueous phase. Transfer of bacteria from the solid phase to the aqueous phase can result in the long-term bacterial release into drinking water supplies posing a potential human health risk. Slow detachment of bacteria from soil particles is often observed but not well understood. By understanding the mechanisms controlling bacterial detachment, we can design ways to protect groundwater against pathogen contamination.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$15,568
State- 43,348
Total – 58,916
Full-time equivalents: Sci 0.2; Prof 0.5; Total 0.7

d. Scope of Impact: State specific

5. Anaerobic cyanobacterial cell maintenance, growth and toxin production

a. Brief description of the activity

Cyanobacteria toxins, microcystins, are found world-wide in lakes and are linked to serious health problems. This project is now examining more closely the biotoxin production under varying ecological and physiological conditions.

b. Short Impact/Accomplishment Statement

Studies of biotoxin production and release have a potential to affect public health whenever/wherever surface waters containing cyanobacteria are used in private or municipal water supplies. Biological control of biotoxin producers may be feasible as demonstrated during the course of this investigation, and is preferable to chemical control measures.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$19,737
State- 47,951
Total – 67,687
Full-time equivalents: Sci. 0.3, Total 0.3

d. Scope of Impact: State Specific

Key Theme - Wildlife Science and Management

1. White-tail deer energetics

a. Brief description of the activity

Winter survival of white-tailed deer and wild turkeys is dependent upon specific forest habitat, winter severity, and relative body condition (fat deposits) before/during winter. This project examines specific physiological and bioenergetic adaptations that enhance their winter survival of white-tailed deer and wild turkeys. The field metabolic rate (FMR) of 8 adult, captive female deer was measured with doubly labeled water in January-February, 2003 and 2004. The body composition of 8 female wild turkeys of variable body weight was measured in February with two methods: deuterium oxide dilution in body water and whole body composition.

b. Short Impact/Accomplishment Statement

The data suggest that deer have an autumnal rhythm of both metabolism and energy intake as physiological adaptations to enhance fat deposition critical for winter survival and subsequent reproduction and recruitment. Therefore, the relationship between autumnal forage/habitat and body condition may not be as direct as believed, and the common use of autumnal body weight to assess herd health may not necessarily reflect the quality of forest habitat, winter survival, or productivity. The low and consistent FMRs measured in captive deer indicate the adaptability of deer to reduce energy expenditure in winter. The FMR data provide baseline values for comparison of future, doubly labeled water measurements in free-ranging deer, and related energy expenditure models. The significant relationship between body weight and %body fat in adult female wild turkeys provides an easy technique to assess their nutritional condition in winter.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - \$30,170
State- 67,419
Total – 92,589
Full-time equivalents: Sci. 0.3; Prof 0.5; Total 0.8

d. Scope of Impact: State Specific

2. Small animal populations and forests

a. Brief description of the activity

Expanding suburban and urban developments have fragmented natural habitats and wildlife populations. This project examines the role of various land uses on long-term survival of wildlife populations. Approximately 2500 patches of suitable habitat were searched for New England cottontails (NEC) in Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island and New York. DNA was extracted from fecal pellets collected at sites for microsatellite analysis. Genetic structure and similarity of these populations were examined at the regional scale using 8 microsatellite loci developed for the European hare. Four of these were polymorphic in NEC and were used to genotype 82 individuals. Samples were divided into 7 potential populations to test for genetic differentiation.

b. Short Impact/Accomplishment Statement

Divergence among subpopulations in the extremes of the range was apparent. At the landscape scale, local populations seem to be connected by anthropogenic features that may facilitate dispersal. Results will substantially increase our ability to identify habitat features that can influence the ability of terrestrial vertebrates to persist in forested habitats that are fragmented by human land uses. Specific results from this investigation also may facilitate restoration of populations of New England cottontails, a species that is being considered for threatened or endangered status by the U.S. Fish and Wildlife Service.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - \$26,020
State- 37,554
Total – 63,574
Full-time equivalents: Sci. 0.3; Prof 0.2; Total 0.5

d. Scope of Impact: State specific

3. Predation effects on food stream webs

a. Brief description of the activity

Salamanders can achieve high densities and biomass in streams; however, few studies have examined the role of salamanders in stream food webs. The response of vernal pool-dependent amphibians was investigated to changes in wetland isolation and surrounding landscape characteristics in southeastern New Hampshire, U.S.A. Repetitive egg mass counts for wood frogs and spotted salamanders was conducted to examine the influence of 24 landscape variables and 7 wetland habitat variables on the use of sites for breeding in these

two species.

b. Short Impact/Accomplishment Statement

Significant factors influencing the number of wood frog egg masses were the distance to the near road, wetland hydroperiod, the percent open water within 1000 m of the study wetland and the number of vernal pools within 300 m of the study wetland. Significant factors influencing the number of spotted salamander egg masses were the distance to the nearest road, wetland hydroperiod, the percent agricultural land use within 1000 m of the study wetland, and the area of continuous forest within 1000 m of the study wetland. Based on the relationships observed in this study, managers seeking to protect vernal pool-dependent amphibians should give highest priority to vernal pools that have a hydroperiod greater than 20 weeks, are not near a road, and are within an area of continuous forest. Successful conservation and management of vernal-pool dependent species requires an understanding of both upland and wetlands requirements. Few empirical studies have been conducted to examine patterns of wetland use by vernal pool-dependant species across both the wetland isolation and upland habitat availability gradients. The results of this study provide valuable guidelines for prioritizing vernal pool protection for vernal pool dependent species.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - \$24,959
State- 45,883
Total – 70,842
Full-time equivalents: Sci. 0.3; Prof 0.7; Total 1.0

d. Scope of Impact: State specific

Key Theme - Other

1. Developing genetic systems for Frankia

a. Brief description of the activity

The purpose of this study is to develop new tools for the genetic manipulation of Frankia. The physical properties of the Frankia genome are being investigated to aid in efforts to exploit the potential of this microbial system to provide renewable resources for fuel and to restore previously disrupted environments. Work on the physical map of Frankia genome has continued and the genome sizes of the three strains (Eu11c, EAN1pec and Cc13) were determined by pulse-field gel electrophoresis of purified DNA both before and after digestion with rare-cutting restriction endonucleases.

b. Short Impact/Accomplishment Statement

A 202 base pair gene sequence was amplified that shares about 80% homology on average with the truncated hemoglobin sequence of *Streptomyces coelicolor*. A preliminary analysis of genome sequences of strain Cc13 and EANp1ed indicated the presence of two truncated hemoglobins. This study has led to the development of essential genetic and genomic tools for this neglected bacterial system. These protocols will aid our efforts to use actinorhizal plants to provide renewable resources for fuel and restore previously disrupted environments.

An understanding of the Frankia genome will help further bioremediation and phytoremediation applications with this system, especially on heavy-metal-contaminated-land.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$24,197
State- 80,035
Total – 104,232
Full-time equivalents: Sci. 0.3, Prof. 0.8, Total 1.1

d. Scope of Impact: State Specific

2. Land ethics

a. Brief description of the activity

Ethics are basic to land-based activity such as the practice of agriculture and natural resource management. Public welfare will be advanced to the extent that we can learn to chart a path toward resource and food sustainability through the observation of a land ethic. The articulation of a land ethic in the context of today's land grant universities is extremely relevant. It is the intent of this study to so articulate that ethic in all of its key dimensions. The study of the four land grant universities (Wisconsin, Iowa State, Maine and Vermont) was concluded. Final field research on intensive rotational grazing (with particular emphasis on Vermont and the Vermont Grass Farmers Association), and on the dairy sector of the agricultural economy (with particular emphasis on Vermont and Maine) was conducted.

b. Short Impact/Accomplishment Statement

Special attention was also given to private non-profit organizations' demonstration/education efforts, to privately owned farms, and to county agricultural extension activities, in addition to campus visits. Expected impact includes an already realized four credit course in applied agrarian values, and a possible new degree program in sustainable agriculture, agroecology and local food systems at UNH within the planned reorganization of the College of Agriculture. In addition to paper presentations, the most tangible impact of H-424 is a published book which will serve as a guide to the use of the Leopoldian land ethic within the land grant universities to help them achieve goals of sustainable agriculture and agricultural land ethics within their teaching, research and extension functions.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$22,094
State- 55,337
Total – 77,431
Full-time equivalents: Sci. 0.3; Total 0.3

Program Duration

The research projects that contribute to Goal 4 are generally of three to five years duration.

All projects are targeted for mid and long term problems.

In fiscal year 2004 the New Hampshire Agricultural Experiment Station had 8.1 full time equivalents of scientist's time assigned to Goal 4. Their research was funded with federal funds from the Hatch, McIntire-Stennis, and Multi-State Research Programs. There were 0 full-time equivalents of technical staff attached to these projects. Professional help in the form of graduate students doing research on these projects amounted to 8.8 students. For this goal, there are matching funds from the State of New Hampshire through a line item within the University of New Hampshire's budget. It is not anticipated that any small changes in federal funding in the next five years would significantly alter the spectrum of key program components for Goal 4.

Goal 5: Enhanced Economic Opportunity and Quality of Life for Americans

Issue:

Research is necessary to help people improve their economic status in order to improve their perceived quality of life.

Overview:

The New Hampshire AES has established as an output indicator for Goal 5, increased applied and basic research to define the issues that improve quality of life, at what expense, and to improve the chances that rural communities can provide these opportunities.

We will evaluate the outcome indicators of 1) more rural communities capable of providing employment opportunities to their residents, and 2) rural communities better able to adjust and adapt to structural changes in agriculture and forestry so that they remain viable and exciting places in which families may reside. We continue a philosophy that the mission of the Agricultural Experiment Station is consistent with Goal 5 and thus provide support to basic and applied sciences that help posture to maintain enhanced economic opportunity and quality of life for Americans. The NH Agricultural Experiment Station supports the following basic and applied projects within Goal 5 to create technology and research for the benefit of the state, region and nation. We believe these projects provided excellent results and value from the investment of AES funds and have positioned the NH AES well to successfully achieve the goals of its five year POW plan. Each of the following projects contributes to maintaining economic opportunity and quality of life.

Key Theme - Community Development

1. Improvement of rural and agricultural sample survey methods

a. Brief description of the activity

To be effective, local state and federal agencies and non-profit organizations need to be able to identify, characterize, and communicate with all stakeholder groups of a specific program or policy. Studies were designed and implemented to assess two distinct stakeholders groups (e.g. commercial fishermen and research scientists) attitudes and behaviors associated with their involvement in cooperative research. In addition, this project designed, developed, implemented and evaluated methods for characterizing and communicating with stakeholders

of distinct resource management programs/policies (i.e., Statewide Comprehensive Outdoor Recreation Planning Communities Response to Change, and a Cooperative Research Program).

b. Short Impact/Accomplishment Statement

Findings suggest that the two stakeholders share common motivations (i.e., to improve the quality of science, professional growth, and financial benefits) and experienced a similar challenge (i.e., securing the application of the results from their cooperative research project in fishery management and policy). The initiative designed has been adapted and used by NH Fish and Game Department and the UNH Cooperative Extension Service. The Web-based Tool has been successfully used to expand the number of people participating in resource management and policy development process. Relative to cooperative research, a methodology for improving both the quantity and quality of data collected through a multi-method study of cooperative research stakeholders has been well received by policy makers, program administrators and the stakeholders. The methods designed and evaluated are under consideration for adoption by other sponsors of cooperative research and has resulted in additional funding cooperative research initiatives in the Northeast.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch

Total expenditures: Federal - \$16,747

State- 38,335

Total – 55,082

Full-time equivalents: Sci. 0.3; Prof. 0.1; Total 0.4

d. Scope of Impact: State Specific

2. Rural economic development alternatives in the northeast (3 projects)

a. Brief description of the activity

The future of rural America depends on decisions made by citizens, businesses, and legislators. The first project is designed to understand the effects of public policy and rural industries. A comprehensive survey of commercial fishermen participating in cooperative research through the Northeast Consortium was conducted in February 2004 and administered through May 2004 to understand what fishermen think about their projects and the relative importance of this program to themselves and the community. The second project is surveying New Hampshire business owners to get a better understanding of how e-commerce has affected their business and what support services would be most beneficial. The third project is examining the health care problem in rural New Hampshire and evaluating alternative policies that could improve the situation.

b. Short Impact/Accomplishment Statement

In the first project, the results showed that the fishermen strongly favored cooperative research, but sometimes feel inconvenienced by conflicting schedules or bad weather, which occasionally results in opportunity costs. Better defining the economic base of a given region using the reported multipliers will make a greater understanding of the unique character of each of these regions. Knowledge of these multipliers should help target investment in

tourism in order to develop this industry in a more sustainable and compatible manner with a local community. The second project is assessing the economic role of the health-care sector in rural areas. The study will show the other economic impacts in addition to loss of health care options for residents if rural hospitals close in the face of economic difficulties. Comparison of consumer internet buying preferences with producer internet selling patterns is shared with the business owners through the 'New Hampshire's Own' program so that they can better know their potential in the e-commerce market. The consumer and producer surveys will be repeated in subsequent years to see if e-commerce shopping and selling patterns change over time in New Hampshire. The third project will measure the importance of a hospital in a rural/semi-rural economy. The study will contribute to an assessment of the economic role played by the health-care sector in rural areas. Many rural hospitals face economic difficulties and might shut down; this study will show the other economic impacts in addition to loss of health care options for rural residents.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$42,958
State- 92,547
Total – 135,504

Full-time equivalents: Sci 0.5; Prof 0.6; Total 1.1

d. Scope of Impact: Multistate; Integrated Research and Extension (AR, CO, DE, IA, IN, MI, MN, NC, ND, NH, NV, NY, OH, OR, PA, SC, TX, UT, VA, WA, WI)

3. Transborder forestry relations

a. Brief description of the activity

This project investigates a bioregional approach to the dimensions of dependency and sustainable development of rural communities in northern New England and southern Quebec on forest resources. Three surveys on sawmills in New Hampshire-Vermont, Maine, and Chaudiere-Appalaches, Quebec, Canada were conducted. It further examines how that dependency impacts wood products trade, bilateral community relations, and the forest resource itself.

b. Short Impact/Accomplishment Statement

New Hampshire-Vermont responding mills were worried about taxes, environmental regulations, weak markets, and indirect labor costs such as workman's compensation. These mills have an experienced work force, ready access to capital and contribute to their local communities. Maine respondents were concerned mostly with cost and availability of logs, markets for products and labor issues, although the relative importance of these factors varied by mill size. If state governments want to maintain forests, for all the environmental, economic and social values forests provide, policy makers should be mindful of how important workman's compensation, environmental regulation, and taxes are to the economic health of the region's sawmill industry. Finally, public actions that increase costs in northern New England will strengthen the perceptions among mill operators that their Canadian competitors enjoy lower stumpage, production, and transportation costs.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - \$22,532
State- 44,208
Total – 66,740

Full-time equivalents: Sci. 0.2, Prof. 0.4, Total 0.6

d. Scope of Impact: State Specific

4. Economic considerations in municipal solid waste disposal

a. Brief description of the activity

Solid Waste Management in the U.S. has become a major problem for local government, especially in rural areas. Specific issues relate to cost considerations, environmental quality, facility sites, and economic efficiency. The purpose of this research is to examine cost effective methods for meeting waste management goals, to assist communities in program design, and to further examine the problems of sites of noxious facilities. A survey of all New Hampshire towns was conducted and data were analyzed to determine the effects of unit based pricing on per capita waste generation.

b. Short Impact/Accomplishment Statement

This study documents the reductions in waste generation that can be obtained with unit based pricing for disposal. On average, New Hampshire towns experience substantial reductions in waste generation with unit based pricing systems. While this indicates that there are cost savings from program adoption, it is not necessarily the case that all towns should adopt unit based pricing. However, at a time when local governments are under ever increasing fiscal stress, this information is extremely valuable in making decisions for alternative program delivery systems, which can reduce operating costs and reduce pressure on local property taxes.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$19,230
State- 65,469
Total – 84,699

Full-time equivalents: Sci. 0.3; Prof 0.5; Total 0.8

d. Scope of Impact: State specific

5. Benefits and costs of resource policies (2 projects)

a. Brief description of the activity

The first project is surveying three NH towns for three issues: 1) looks at towns that have had ballot measures to preserve open space; 2) consumer surveys to gauge willingness to pay for products that come from agriculture or forestry; and 3) asks small business owners to assess their business. The second project focuses on the influence of community gardening on community empowerment.

b. Short Impact/Accomplishment Statement

The study from the first project was conducted prior to the launch of the 'New Hampshire's Own: A Product of Yankee Pride' marketing campaign. The study will be repeated in the following years to estimate the impact of that campaign on New Hampshire businesses, especially agricultural businesses. In the second project if a gardening organization maintains a certain level of capacity-based on a given set of indicators that will be identified as a result of this research-they will have a greater chance of sustaining their community garden plot, particularly when the mere existence of the garden is threatened by external forces.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - \$38,383
State- 84,339
Total – 122,733

Full-time equivalents: Sci. 0.6, Prof. 0.4; Total 1.0

d. Scope of Impact: Project 1 – Multistate; Integrated Research and Extension (AL, CA, CO, GA, IA, KY, LA, MA, ME, MI, NC, ND, NH, NYC, PA, TX, OH, OR, UT, WA,

WV, WY)

Project 2 – Multistate research (AL, CA, CO, GA, IA, KY, LA, MA, ME, MI, NC, ND, NH, NYC, PA, TX, OH, OR, UT, WA, WV, WY)

6. Welfare reform and the well-being of rural low-income families

a. Brief description of the activity

This project has tracked over time the individual and family circumstances, functioning and well being of rural low-income families with children in the context of welfare reform. This project worked on three objectives 1) to assess across time the relative effects of economic opportunity and personal attributes and actions, on employment and self-sufficiency among the rural low income families participating in this study and 2) to collect additional data in year 3 of this study to track the functioning of the participating families related to changing policies and economic conditions and 3) to assess the well being of participating NH rural families with regard to health, food security, employment, and receipt of public assistance.

b. Short Impact/Accomplishment Statement

The project website (<http://www.ruralfamilies.umn.edu>) has facilitated data sharing for the multi-state project researchers. Central data processing has facilitated the merging of the multi-state data that has revolved around three themes: food security, economic well-being, and health. The findings related to food security indicate a need for more concerted educational efforts on budgeting and meal planning for those who are food insecure. Employment data indicate that the primary barriers to overcome are job availability, child care, and transportation. Lastly, participation in this study has decreased the isolation of the participants, which is endemic among this population, allowing them to feel more connected to others as well as to the community. A website devoted to the NH project and outcomes is under construction and should be available in 2005.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal \$6,388
Total 6,388
Full-time equivalents: Total 0.0

d. Scope of Impact: Multistate; Integrated Research and Extension (CO, IN, KY, LA, MA, MD, MI, MN, NE, NH, NYC, OH, OR, UT, WY)

Program Duration

The research projects that contribute to this goal are generally of three to five years duration. All projects are targeted for mid and long term problems.

In fiscal year 2003 the New Hampshire Agricultural Experiment Station had 1.9 full time equivalents of scientist's time assigned to Goal 5. Their research was funded with federal funds from the Hatch, McIntire-Stennis, and Multi-State Research Programs. There were 0 full-time equivalents of technical staff attached to these projects. Professional help in the form of graduate students doing research on these projects amounted to 2.0 students. For this goal, there were matching funds from the State of New Hampshire through a line item within the University of New Hampshire's budget. It is not anticipated that any small changes in federal funding in the next five years would significantly alter the spectrum of key program components for Goal 5.

B. Stakeholder Input

The N. H. Agricultural Experiment Station has developed an Advisory Committee, **representing a diverse group of stakeholders**. The group will meet about twice per year to exchange ideas for increasing this station's effectiveness in serving stakeholders and the citizens of our state. The station welcomes stakeholder input through this committee as well as individually. The Advisory Committee is comprised of the following members:

David Babson

N. H. State Representative

Nancy Berliner

N. H. Rural Development Council

Bill Berndtson

UNH Animal Sciences

Hal Bodwell

Dairy producer

Bruce Clement

UNH Cooperative Extension

Sharon Francis

Connecticut River Joint Commission

Deanna Howard

Dartmouth-Hitchcock Medical Center

Jeff Huntington

Pleasant View Gardens

Barry Kelley

Forest industry

Tom Kelly

UNH Sustainability Program

Peter Lamb
New Hampshire Charitable Foundation

Jeanie McIntyre
Upper Valley Land Trust

John McLean
UNH Farm Manager

Dean Moreau
Yankee Farm Credit

Anne Sprague
Edgewater Farm

Chris Streeter
Blue Seal Feeds
N. H. CARET representative

Edith Tucker
The Coos County Democrat

1. Publications targeted largely to stakeholders have been produced and each sent to an audience of approximately 10,000 per issue. Yearly issues of "INSIGHTS" address events, people and contributions from the College of Life Sciences and Agriculture (COLSA) and the NH AES. A separate issue of "Research Highlights" emphasizes the contributions and impacts of research sponsored by the NH AES and COLSA. Constituent reaction to these NH AES publications is encouraged.
2. The Research Advisory Committee continued to assist the Agricultural Experiment Station administration in AES proposal reviews and to recommend research areas of State and regional importance for particular AES focus.
3. The NH AES Director served on the NH Current Use Board, attended community fact-finding meetings and served on the State Conservation committee to obtain stakeholder input.
4. The NH AES has been a participant in several State Fairs as well as the NH Farm and Forest Exposition. These activities facilitate direct stakeholder input.
5. The NH AES Director attended meetings with the Farm Bureau, representatives of the NH Horticulture Association the NH Equine Committee, and the Farm and Forest Expo Leadership.
6. Representatives of the NH AES have visited NH farms, orchards, greenhouses and extension twilight meetings to speak directly with constituents.

B. Statement of the process used to identify stakeholders and collect input.

We will continue to meet twice a year with the NH-AES Advisory Committee to exchange ideas for making this station most effective in serving stakeholders and the citizens of our state. We expect that other, regular means of communication will be implemented as this new initiative progresses.

In addition to the interaction with our Advisory Committee, the NH AES sends its INSIGHT and Research Highlights publications to citizens of the state and region requesting

input on research areas, concerns and needs. The NH AES and the College of Agriculture representatives accompany a prepared display to state and regional fairs and expositions to meet stakeholders, distribute information and obtain input. The NH AES Administrators also meet stakeholders and acquire input by presenting talks at meetings of various grower groups, the Grange and Farm Bureau. The AES Administrators and others working with the NH AES visit state and regional farms, orchards, greenhouses, and extension meetings to assess needs and collect input. The AES Administrators frequently travel to different counties with Extension Specialists to obtain input on integrated needs.

C. Statement of how collected information was considered.

Information from a variety of stakeholder sources has been incorporated into AES policy. Concerns over AES-funded projects that might better serve the needs of the state and region led to a change in the criteria for evaluating AES program proposals. An explanation of how the project will impact state and/or regional needs is now required. Concerns over limited support for horticulture, the fastest growing area of the NH agricultural economy, and concerns for water quality have led to AES project funding targeted in those two areas. In addition to our expanded efforts to identify and engage stakeholders, the NH-AES has begun efforts to have a survey instrument developed to assess the needs of a larger population of stakeholders. The AES is sponsoring **(with preparation through the UNH Department of Resource Economics)** the creation of a survey instrument and the survey of New Hampshire citizens to obtain input on the needs and results of AES projects as defined by the five national goals. Additionally, the Advisory Committee assists the AES to identify important current and emerging needs, and to advise the AES on matters such as preferred mechanisms for timely delivery of research findings to end users.

C. Program Review Process

The New Hampshire Agricultural Experiment Station has had a peer review process for projects for over fifteen years. The proposal process applies to all Goals and is as follows. Each August a letter is sent to all faculty in the College of Life Sciences and Agriculture and to Deans of other Colleges announcing a competition for Hatch and McIntire-Stennis funds. Faculty must submit a one page description of their proposed project and subsequently meet with the AES Associate Director to discuss the work. If the proposed project is determined to fit within the guidelines for support from either of these two funds, the faculty member develops a full proposal using the CSREES/USDA format. Faculty must also suggest five potential external (non-UNH) peer reviewers from whom the Associate Director obtains at least two anonymous reviews. After the reviews are returned, the faculty member then has the opportunity to revise the proposal or rebut the reviewer's comments, if they wish. The next step in the process is the project funding priority evaluation performed by an internal committee of five faculty members who are experienced in research. All proposals are reviewed, taking into account the external reviewer's evaluations and the faculty member's response. From this, the committee recommends a priority for submission to USDA for approval. The AES Administrators use this recommendation and their own evaluation to make the final decision as to which projects the Experiment Station will fund. Usually about 80% of the proposals submitted are forwarded to CSREES/USDA for their approval for funding. We will continue this process in New Hampshire. However, we have modified it to utilize the results of stakeholders input. When the

call for proposals is sent out each year, it now includes guidelines of the criteria used for internal proposal evaluation. These criteria include, 1) research quality and potential, 2) how the proposal addresses state, regional and stakeholder issues, 3) the quality of the prior year progress report, and 4) outcomes (including publications and grant submissions) from the work performed.

D. Evaluation of the Success of Multi and Joint Activities

1. Did the planned programs address the critical issues of strategic importance.

The NH AES is involved with multi-state and joint activities focusing on topic areas that are included in our POW. Each area and project addresses a critical issue of strategic importance as described by its placement within the list of the five national goals above. These activities include:

- Genetic bases for resistance to avian diseases
- Improved supply of nutrients to dairy cows
- Predicting bovine fertility
- Improving nutrition for dairy calves
- Control of plant growth systems (also extension)
- Genetics and breeding of Cucurbita (not listed as multistate)
- Strawberry production in modified environments
- Evaluation of new apple cultivars(also extension)
- Conservation of plant genetic resources
- National Animal Genome Research Program
- Assessing the nutritional risk of the elderly
- National atmospheric deposition program
- Impact sewage biosolid application to agricultural soils
- Rural economic development alternatives in the northeast
- Benefits and costs in natural resource planning
- Welfare reform and the well-being of rural low-income families

Many of these projects originated as the result of stakeholder input and continue to address stakeholder needs.

2. Did the planned programs address the needs of under-served and under-represented populations.

While not all of the multistate and joint projects were designed to serve the under-represented and under-served populations, most of the projects in the multistate list above do, in fact, directly serve under-represented and under-served populations. These include the poor, the homeless, small communities with less than adequate resources and representation, families in rural areas, the elderly, the undernourished, those seeking self-sufficiency, and farmers seeking new crops or replacement crops for species with declining sales, among others.

3. Did the planned programs describe the expected outcomes and impact.

Individual projects are at different stages of maturity and have exhibited different levels of

impact. Each multistate and joint project, in our opinion, has been a sound investment of federal and state funds, thereby continuing research progress and benefiting the citizens of the state and region. Examples of the outcomes and impact derived from these projects are indicated below.

Examples below indicate some of the outcomes and impacts derived from these projects.

- The Ruminant Feed Analysis Consortium resulted from two Hatch and multistate projects. The consortium represents a collaborative effort among researchers, feed testing laboratories, and the commercial feed industry to analyze ruminant feed, quantify relationships between the chemical composition of feeds and nutritive value, and stimulate feed analysis development and standardization.
- Lactoferrin may increase intestinal development resulting in more efficient nutrient use and healthier calves. Research indicates that lactoferrin, is effective in high protein milk replacer feeding programs and appears to enhance intestinal development.
- Improving reproductive efficiency is an economic concern to the cattle industry. Research to understand late embryonic/early fetal mortality in cattle and to determine effects of environmental/metabolic stressors will assist the design of improvement strategies.
- Poultry health will be improved by greater understanding of the genes that affect avian immunity. Improved health represents a substantial economic benefit to poultry breeders and producers.
- The first in-depth methodology using the American lobster has been developed for determining the area fished by a lobster trap. These data and technology will be used to obtain better estimations of the abundance of lobsters, and thus determine fishing impact on the lobster population.
- Breeding of squash, gourds, and tomatoes has improved productivity, decreased harvest injury, and enhanced produce quality. The results offer new crop opportunity for farmers as well as a new sales opportunity for retailers.
- Genetic and genomic tools have been developed to enable more effective identification, preservation and utilization of wild strawberry germplasm. This will enable the development of improved cultivated varieties.
- Successful hatchery production of juvenile sea urchins was accomplished for the seventh year in a row, confirming that a hatchery for urchin aquaculture is feasible.
- Modifiable factors such as dietary carotenoids and weight appear to decrease risk of aging-related eye disease. These findings have significant public health implications to prevent eye diseases.
- Obesity, characterized by excess adipose tissue accumulation, has reached epidemic proportions world wide. The findings from this study contribute to our understanding of

how fat cells may regulate their own size.

- Cardiovascular disease is the number one cause of mortality in American men and women. The findings from this study have established a model system using the hamster for studies on atherosclerosis.
- The impact of genetic and environmental influences on elemental and phytochemical contents has been determined of the vegetable Brassicias. Brassicias are significant sources of RDA nutrients as well as beneficial health promoting phytonutrients, such as carotenoids. Research results have been provided to stakeholders through publications and web-site dissemination.
- Genomic resources developed to identify the genetic basis for several commercially important traits in tilapia, including sex, skin color and salinity tolerance have immediate applications for breeding improved strains of tilapia.
- Changes in NH state regulations resulted from NH AES research on land application of sludge biosolids. Previous regulations and permit conditions were not sufficient to protect groundwater quality at sites undergoing repeated biosolid applications.
- Opinions and motivating factors for buying New Hampshire made products and services were identified from out-of-state visitors. The work was in conjunction with the 'New Hampshire's Own: A Product of Yankee Pride' marketing campaign.
- Solid waste management in the U.S. has become a major problem for local government, especially in rural areas. The reductions in waste generation were documented. The information obtained is valuable in making decisions for alternative program delivery systems which can reduce operating costs and reduce pressure on local property taxes.
- State and national leaders can use the results of research on rural communities to design strategies for strengthening their economies. Investments should be targeted in health-care, tourism, and e-commerce.
- Individual and family circumstances, functioning and well-being of rural low-income families with children in the context of welfare reform have been tracked. Central data processing has effectively facilitated the merging of information on food security, economic well-being, and health themes.

4. Did the planned programs result in improved effectiveness and/or efficiency.

Multistate research has allowed NH to leverage its results beyond the value of the funds expended. We have increased communication and coordination among states but decreased duplication of efforts. Multistate research expenditures have the best project return for dollars invested across the NH portfolio of AES-sponsored research. Further efficiency has been realized through efforts to improve our integrated research. Communication between the NH

AES and NH-Extension had become poor because the two entities did not have same University reporting lines. Efforts to improve integrated research have enhanced communication and provided the opportunity for effective collaboration.

E. Multistate Extension Activities

This section is not applicable to the NH-AES

F. Integrated Research and Extension Activities

From the table of integrated projects below, one may see that the NH AES spent at least \$375,824 of a combined Federal allocation for Hatch and Multistate of at least \$ 1,367,602. This represents a 27.5% integrated portfolio, in excess of the 20% agreed to in FY 2000. Pertinent information is included in the table below. A brief description of the progress to date on each planned activity follows the table.

Integrated Projects

Name	Project Number	Project description	FY 2004
Loy J. Brent	H-462	Conservation and utilization of plant genetic resources	Federal \$ 14,061
Lord William	H-375	Multidisciplinary evaluation of new apple cultivars	Federal \$ 7,659
Kocher Thomas	H-397	Genetic maps of aquaculture species	Federal \$ 11,630
Taylor Robert	H-459	Genetic bases for resistance and immunity To avian diseases	Federal \$ 23,920
Fisher Paul	H-463	Developing and integrating components for commercial greenhouse production system	Federal \$ 9,071
Curran-Celentano Joanne	H-374	Nutritional risk and antioxidant status in the elderly	Federal \$ 29,343
Margolin Aaron	H-414	Application of sewage biosolids to agricultural soils in the Northeast: Long-term impacts and beneficial uses	Federal \$ 9,427
McDowell William	H-415	Application of sewage biosolids to agricultural soils in the Northeast: Long-term impacts and beneficial uses	Federal \$ 13,167
Giraud Kelly	H-442	Rural communities, rural labor markets and public policy	Federal \$ 10,364
	H-443	Benefits and costs of natural resources policies affecting public and private lands	Federal \$ 14,758
Schwab Charles	H-447	Metabolic relationships in supply of nutrients for lactating cows	Federal \$ 27,941
	H-448	Management systems to improve the economic and environmental sustainability of dairy enterprises	Federal \$ 25,884
Townson Dave	H-444	Ovarian and environmental influences on embryonic/ fetal mortality in ruminants	Federal \$ 19,917

Giraud, Kelly H-443 Benefits and costs of natural resources policies affecting public and private lands

This study was conducted before the launch of the 'New Hampshire's Own: A Product of Yankee Pride' marketing campaign. The study will be repeated in the following years to estimate the impact of that campaign on New Hampshire businesses, especially agricultural businesses.

Schwab, Charles H-366 Metabolic relationships in supply of nutrients for lactating cows

Improving the efficiency of conversion of feed protein to milk protein is fundamental to both environmental and economic sustainability of the US dairy industry. This study has focused on ruminally-protected amino acids to enhance protein utilization, to increase milk protein and to decrease nitrogen excretion. More precise feeding for protein increases the conversion of feed nitrogen to meat and milk protein. This reduces the potential for nitrogen pollution and decreases feed costs.

Schwab, Charles H-448 Management systems to improve the economic and environmental sustainability of dairy enterprises

The research will allow for more precise protein and amino acid formulation of dairy cattle diets. The result will be increased conversion of feed nitrogen to animal protein. This will not only reduce losses of excreted nitrogen, which is of growing environmental concern, but it will also increase dairy herd profitability.

Townson, Dave H-444 Ovarian and environmental influences on embryonic-fetal mortality in ruminants

This project has examined the relationship of uterine involution to resumption of ovarian function following parturition. While uterine fluid collections in postpartum cows do not appear to affect ovarian function per se, conception rate is diminished in cows with large fluid collections. Further study of uterine involution in the postpartum cow with regard to conception is warranted, and offers tremendous potential for improving fertility in multiparous cows.

Tsang, Paul H-445 Ovarian and environmental influence on embryonic/fetal mortality in ruminants

Elucidating the mechanisms by which heat stress affects ovarian function may provide insight toward understanding the lower fertility rates associated with high environmental temperatures during the summer in the northeastern United States. This may lessen the economic loss to dairy producers. Also, determining how structural modifications alter ovarian function may provide insight toward understanding their effects on reproductive cyclicity and fertility.

Morris, Douglas

H-449 Rural communities, rural labor markets and public policy

This program showed that the fishermen strongly favored cooperative research, but sometimes feel inconvenienced by conflicting schedules or bad weather, which occasionally results in opportunity costs. Better defining the economic base of a given region using the reported multipliers will make a greater understanding of the unique character of each of these regions. Knowledge of these multipliers should help target investment in tourism in order to develop this industry in a more sustainable and compatible manner with a local community.

Erickson, Peter

H-450 Management systems to improve the economic and environmental sustainability of dairy enterprises

Lactoferrin may increase intestinal development resulting in more efficient nutrient use and healthier calves. Up to now, lactoferrin has only been evaluated in conventional milk replacer feeding regimens. This study will determine its efficacy in high protein milk replacer feeding programs and whether lactoferrin enhances intestinal development. Chlortetracycline is not beneficial in improving heifer reproductive performance.

Manalo, Alberto

H-442 Rural communities, rural labor markets and public policy

The program is examining the health care problem in rural New Hampshire and evaluating alternative policies that could improve the situation. The study will contribute to an assessment of the economic role played by the health-care sector in rural areas. Many rural hospitals face economic difficulties and might shut down; this study will show the other economic impacts in addition to loss of health care options for rural residents.